0071252

WCH-93
Rev. 0

River Corridor
Closure Contract

Conceptual Design Report for the 105-N/109-N Interim Safe Storage Project

August 2006

Washington Closure Hanford

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Assistant Manager for River Corridor

DOCUMENT CONTROL 8/30/06 DD

WCH-93
Rev. 0
OU: N/A
TSD: N/A
ERA: N/A

STANDARD APPROVAL PAGE

Title: Conceptual Design Report for the 105-N/109-N Interim Safe Storage Project

Author Name: M. R. Morton, Polestar Applied Technology

Approval: E. G. Ison, RISS Project Engineer

Eric G. Ison

Signature

08-30-06

Date

R. G. Egge, D4 Technical Services Manager

Robert G Egge

Signature

8-30-06

Date

The approval signatures on this page indicate that this document has been authorized for information release to the public through appropriate channels. No other forms or signatures are required to document this information release.

WCH-93
Rev. 0

River Corridor
Closure Contract

Conceptual Design Report for the 105-N/109-N Interim Safe Storage Project

August 2006

Author:
M. R. Morton
Polestar Applied Technology

Washington Closure Hanford
Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Assistant Manager for River Corridor

EXECUTIVE SUMMARY

This conceptual design report has been generated to meet *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Milestone M-93-19 (Ecology et al. 1989) and defines the scope and recommended processes for the final deactivation, decontamination, decommissioning, and demolition (D4)/interim safe storage (ISS) of the 105-N Reactor Building and the 109-N Heat Exchanger Building in accordance with approved *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* documents. The purpose of the D4 activities is to dismantle the facilities and dispose the demolition waste in a safe, appropriate, and cost-effective manner in accordance with the approved regulatory documents. Preparation for ISS will include construction of a safe storage enclosure utilizing the shield walls of the 105-N and 109-N Buildings.

At the time Tri-Party Agreement Milestone M-93-19 was established it was not known if the 105-N Building could be placed into ISS because of the different design/layout. Originally this report was to evaluate potential options for D4/long-term surveillance due to the potential that ISS may not have been practical. Experience gained from placing 105-D, 105-DR, 105-F, and 105-H into ISS and further evaluation of the 105-N configuration has shown that ISS of 105-N/109-N is practical and provided enough information to evaluate the ISS option in the *Engineering Evaluation/Cost Analysis for the 105-N Reactor Facility and the 109-N Heat Exchanger Building* (DOE-RL 2004). The *105-N Reactor Building and 109-N Heat-Exchanger Building Action Memorandum* (Ecology 2005) selected the ISS option for 105-N/109-N. With the ISS option selected for 105-N/109-N, the focus of this conceptual design report is to develop a more detailed conceptual design and clarify the expected "as-left conditions" for long-term surveillance and maintenance.

The conceptual design effort for the safe storage enclosure evaluated the potential viable design options and selected a design that best provides a structure that meets the goals and requirements, minimizes the number of shop drawings required, and meets the design life and functionality requirements for the enclosure.

TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

ACRONYMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
D4	deactivation, decontamination, decommissioning, and demolition
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air (filter)
ISS	Interim Safe Storage
NEPA	*National Environmental Policy Act of 1969*
RL	Richland Operations Office
SSE	safe storage enclosure
S&M	surveillance and maintenance

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This conceptual design report defines the scope and recommended processes for the final deactivation, decontamination, decommissioning, and demolition (D4)/interim safe storage (ISS) of the 105-N Reactor Building and the 109-N Heat Exchanger Building in accordance with approved *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) documents. The purpose of the D4 activities is to dismantle portions of 105-N and 109-N and dispose the demolition waste in a safe, appropriate, and cost-effective manner in accordance with the approved regulatory documents. Preparation for ISS will include construction of a safe storage enclosure (SSE) utilizing the shield walls of the 105-N and 109-N Buildings.

The *105-N Reactor Building and 109-N Heat-Exchanger Building Action Memorandum* (ASA) (Ecology 2005) called for "D&D of the pressurizer tank system, and the penthouse structure surrounding the pressurizer tank" from the 109-N facility; however, subsequent evaluation determined it would be more effective and as low as reasonably achievable (ALARA) not to breach the shield wall as would be required to accomplish this activity. Therefore, the pressurizer tank system and the penthouse structure surrounding the pressurizer tank will be left in place. This will be brought to the Unit Manager's meeting for incorporation into the ASA.

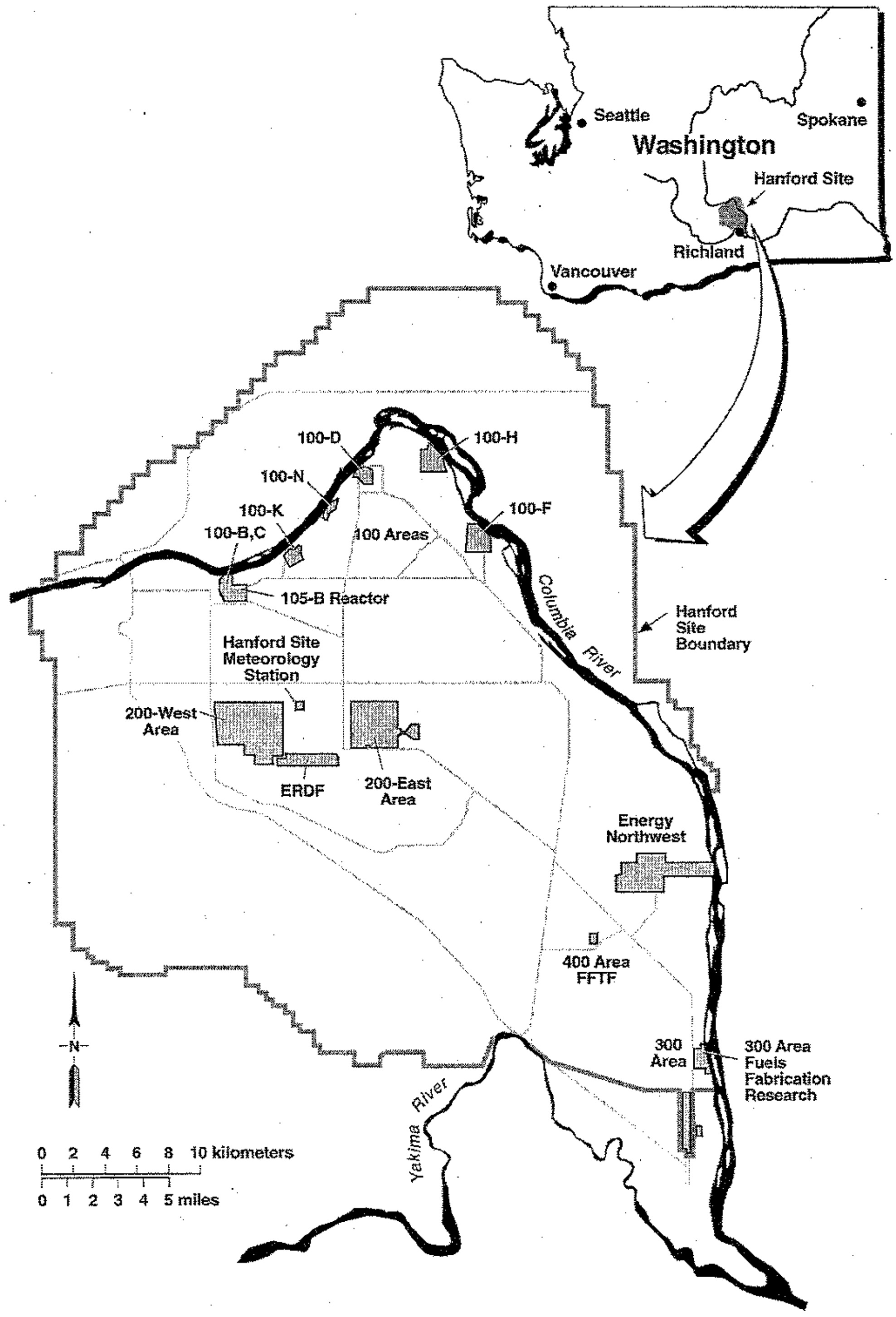
The N Reactor complex consists of the 105-N Reactor Building (N Reactor or 105-N), the 109-N Heat Exchanger Building, and adjacent buildings and is located in the 100-N Area of the Hanford Site. The U.S. Department of Energy (DOE), Richland Operations Office (RL) has determined that there is no further use for the N Reactor (DOE-RL 1994a). A final disposition decision for the N Reactor has not been made and will be subject to later evaluation and implementation. The interim decision to place 105-N/109-N into ISS was proposed in the *Engineering Evaluation/Cost Analysis* (DOE-RL 2004) and authorized in the *105-N Reactor Building and 109-N Heat-Exchanger Building Action Memorandum* (Ecology 2005).

Effluent pipelines leading from the N Reactor complex to waste disposal facilities have been addressed in a separate decision document (Ecology 2005). In addition, contaminated soils associated with the N Reactor complex are generally excluded from this evaluation and are deferred to the remedial action program for the 100-NR-1 Operable Unit.

1.2 BACKGROUND

The Hanford Site is a 1,517-km^2 (586-mi^2) federal facility located in southeastern Washington State along the Columbia River (Figure 1-1) and operated by RL. From 1943 to 1990, the primary mission of the Hanford Site was production of nuclear materials for national defense. The 100 Area is the site of nine now-retired nuclear reactors and associated support facilities that were constructed and operated to produce weapons-grade plutonium. Past operations, disposal practices, spills, and unplanned releases resulted in contamination of the facility structures, underlying soil, and underlying groundwater in the 100 Area. Consequently, in November 1989, the 100 Area was one of four areas of the Hanford Site that was placed on the U.S. Environmental Protection Agency's (EPA's) National Priorities List under CERCLA by the *Superfund Amendments and Reauthorization Act of 1986*.

Figure 1-1. Hanford Site Map.



The 100-N Area is that portion of the 100 Area containing the N Reactor and supporting facilities. The N Reactor operated from 1963 until 1987, at which time it was placed in standby mode. In 1990, DOE made the decision that the reactor would not be restarted, and the N Reactor and ancillary facilities were deactivated. Deactivation was completed in 1998. The reactor has been in surveillance and maintenance (S&M) mode since that time. A final disposition decision for the N Reactor has not been made. It is likely that the decision will be consistent with the approach taken for the other eight reactors in the 100 Area. Disposition alternatives for those reactors were evaluated under the *National Environmental Policy Act of 1969* (NEPA) in the draft and final *Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland Washington* (DOE 1989, 1992). The selected disposition approach for the eight reactors as recorded in the record of decision, placed in ISS, followed by deferred one-piece removal (58 *Federal Register* [FR] 48509). The final evaluation report for the disposition of the surplus reactors will be completed in 2005, per the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (Tri-Party Agreement) Milestone M-93-25, "Submit an Engineering Evaluation of the Final Surplus Reactor Disposition to EPA and Ecology."

1.3 PROJECT-SPECIFIC ISSUES AND RESOLUTIONS

Three technical issues were identified for this investigation. The issues and possible path forward resolutions are as follows:

1. **Underground utilities and process lines.** The areas around and under facilities within the scope of this conceptual design report may contain utilities, process lines, and contaminated soil that are tied to facilities not included in the scope of this report. To what extent should these materials be included in remediation of the 100-N ancillary facilities?

   Resolution: Utilities, process lines, and contaminated soils associated with facilities will be removed as part of the building removal process to within 1 m (3 ft) of the excavation boundary. Alternatively, the excavation zone required to gain access to the below-grade structures in order to facilitate demolition will contain underground lines and utilities connection systems. These systems and lines will be removed in order to facilitate this access zone. All remaining lines will be identified and documented as needed in the waste sites database during final remediation of the reactor area.

2. **Roof slope does not match previous SSE design on other reactor buildings.** The new roof slope adopted at the 105/109-N SSE is 1/4:12 pitch as compared to as much as 9:12 pitch at other reactors.

   Resolution: The 1/4:12 roof slopes meets the International Building Code (IBC) (IBC 2003) standing seam roof requirements. In addition, the current roof slope of the existing structures as originally designed and installed for the operations and S&M time frame was 1/4:12. The slope is considered adequate for the climatic conditions on the Hanford Site and will meet the intent of the SSE storage period (present to 2068).

3. **N Fuel Storage Basin precludes open air demolition in its current state.** The basin was deactivated with the whole of N Reactor in the late 1990s. That project prepared the facilities for long-term S&M to an adequate degree, but did not remove enough source term from the basin to allow open air demolition.

Resolution/path forward: Investigation and quantification of the basin source term should be refined and mitigation measures evaluated to either:

a. Show that open air demolition is feasible because the current source term estimate is too high.

b. Develop and implement an encapsulation process for the source term that will prevent release and allow open air basin demolition.

c. Develop and implement a concrete surface removal or decontamination process (prior to building demolition) to lower the source term to allow open air demolition.

2.0 FACILITY DESCRIPTIONS AND CURRENT CONDITIONS

The following sections provide descriptions of the operating buildings, systems, processes, and process materials related to the scope of the 105-N/109-N ISS Project. Figure 2-1 provides a schematic cut-away diagram of the main portion of the N Reactor as a reference for the systems described in the following sections. Figures 2-2 and 2-3 show both the current and post-ISS footprint and layout of the 105-N/109-N Complex.

Figure 2-1. Schematic Cut-Away Diagram of N Reactor Complex.

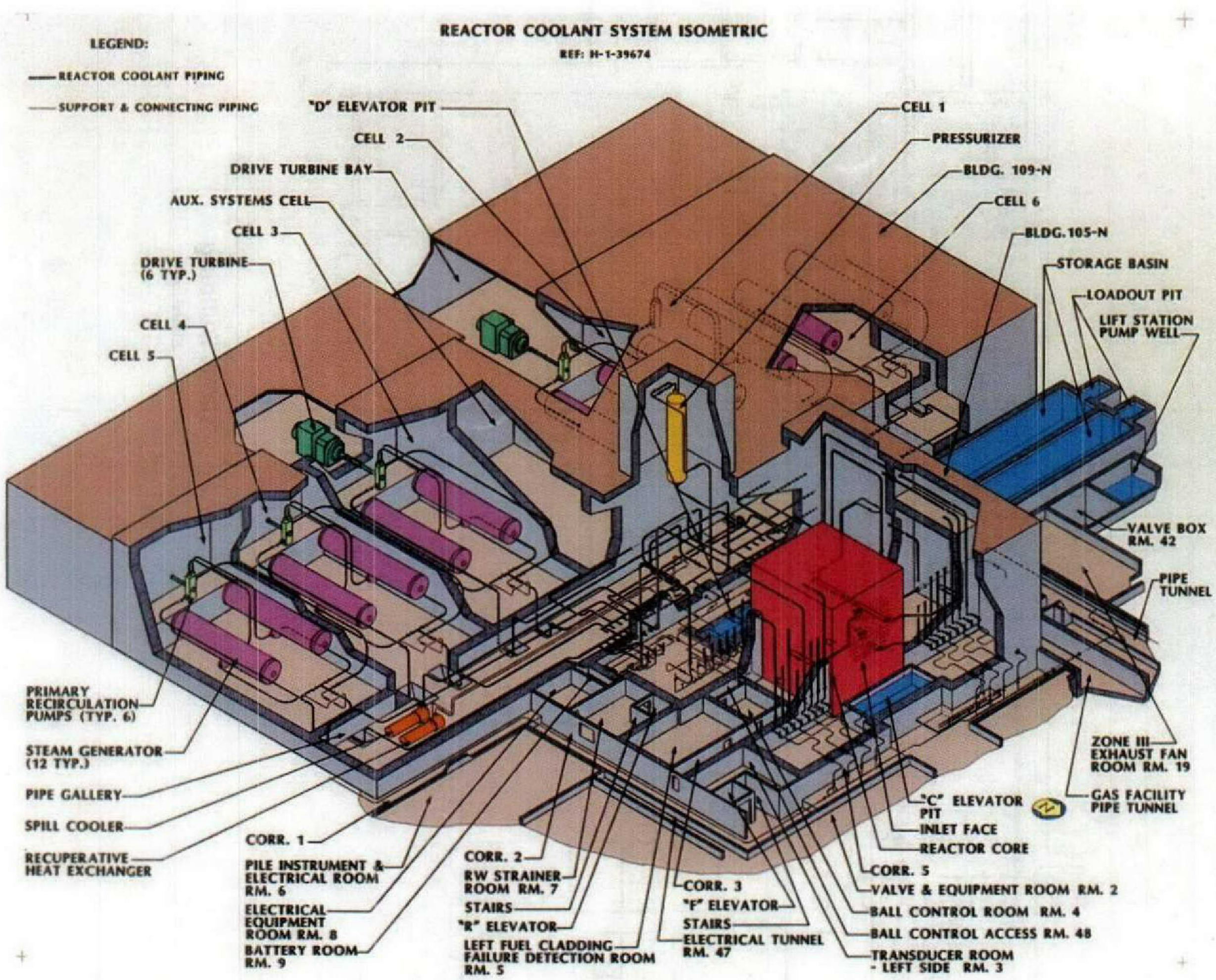
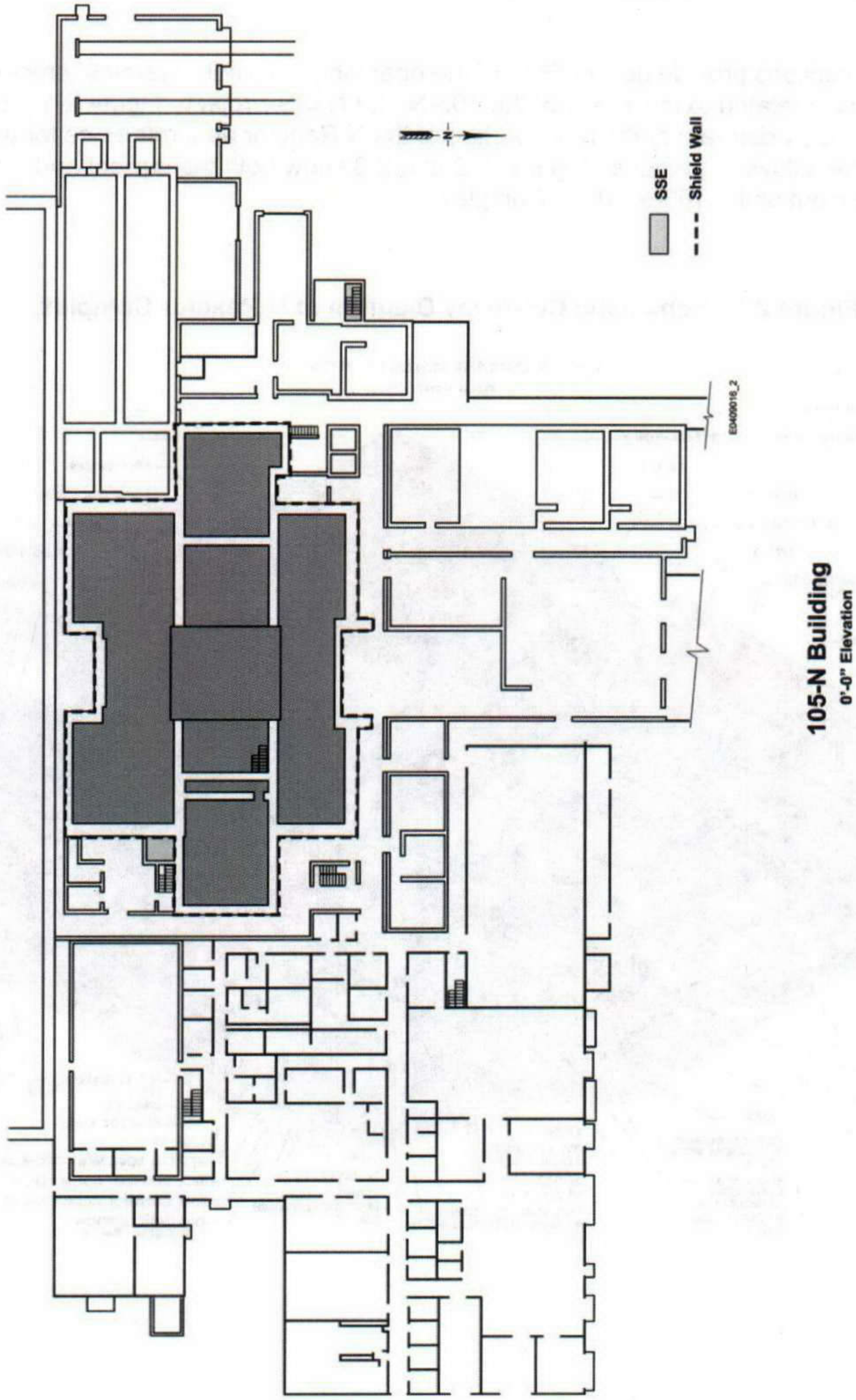


Figure 2-2. 105-N Floor Plan, 0-ft Elevation.



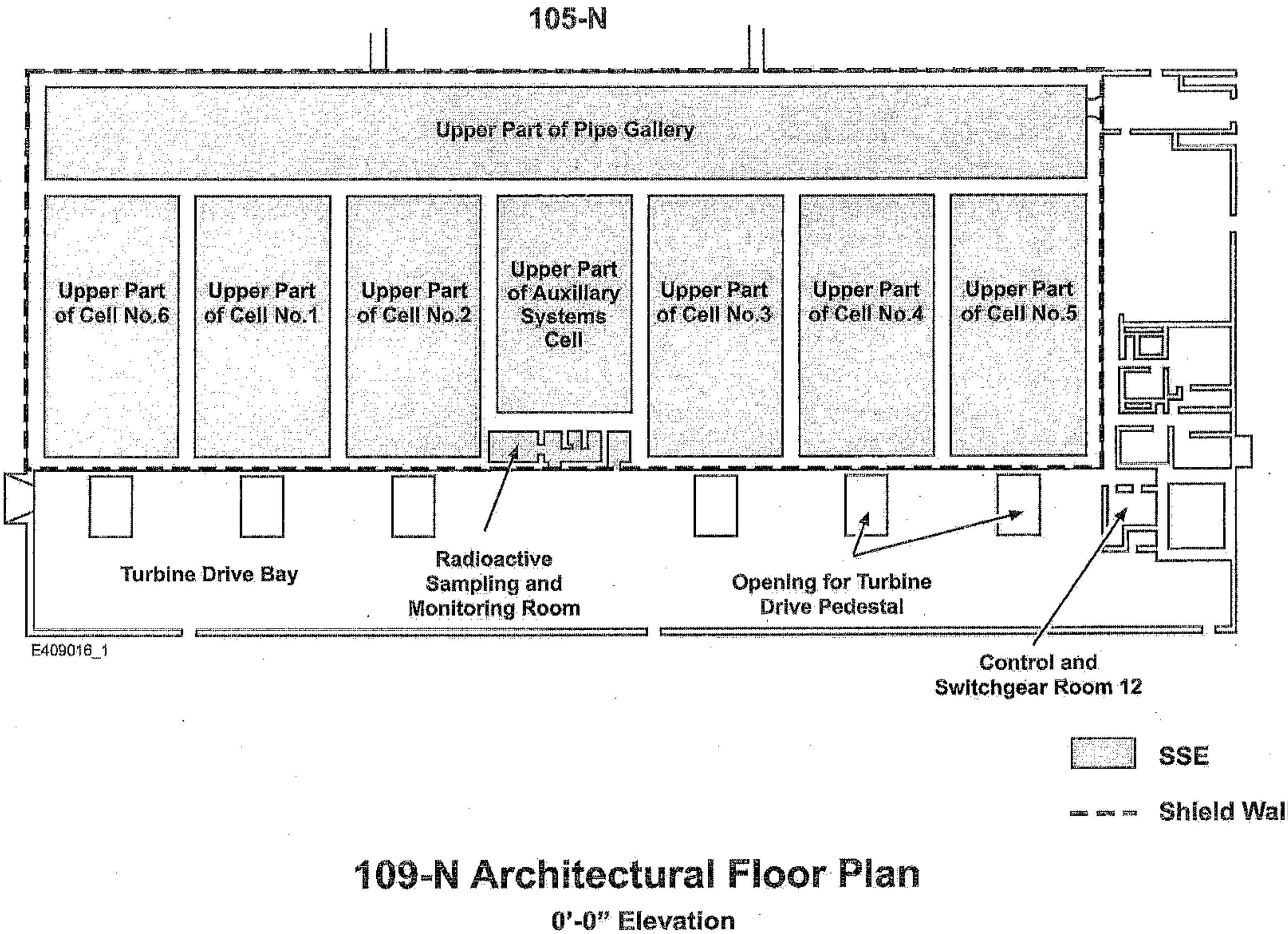


Figure 2-3. 109-N Floor Plan, 0-ft Elevation.

2.1 EXISTING REFERENCES

The documents identified in Table 2-1 were used to support the description, process history, deactivation activities, and previous sampling/analysis performed on the 105-N/109-N Buildings.

Table 2-1. Existing Historical References. (4 Pages)

Reference	Summary
Activity Conversion Factors for 100-N Facilities, 0100N-CA-N0018	Calculates the radioactivity conversion factors for estimating radionuclide surface or mass specific radioactivity concentrations in selected 100-N facility areas/equipment based on in-plant dose rate measurements.
Radionuclide in 105-NE, 1305-N, and 1304-N, 0100N-CA-N0025	Calculates the radioactive material inventory in the 105-NE Fission Products Trap, associated 1305-N piping, and the 1304-N Emergency Dump Tank.
Characterization of Mixed Sediment in North Cask Pit and Basin Water, 0100N-CA-N0038, Rev. 1	Calculates the physical, chemical, and radiological characteristics of the combined sediments and water to be disposed from the 105-N Basin (based on Hanford Environmental Information System sample data).
Residual Quantities After N Basin Cleanup, 0100N-CA-N0044, Rev. 1	Calculates the quantity of materials removed from the N Basin segment and the quantity of materials that will remain after deactivation is completed.
Residual Radioactive Inventory After N Basin Cleanup, 0100N-CA-N0045	Calculates inventory of residual radioactive material remaining in N Basin at end of deactivation.
Radionuclide Inventory in 117N Building and 116N Stack, 0100N-CA-N0048	Calculates the total curies of radioactivity in the 117-N and 116-N facilities, based on radiological survey data taken in 1997 and 1998.
105-N Reactor Building Residual Radioactivity Estimate, 0100N-CA-N0049	Calculates the total residual radioactivity in the 105-N Reactor structure (decayed to 1997).
C Elevator Pit Curie Content, 0100N-CA-N0057	Engineering calculation of the amount of radioactive material in the C elevator pit in 105-N. Calculation uses 105-N Basin water and sediment radionuclide and activities.
105-N and 109-N Final Hazard Categorization for ISS, 0100N-CA-N0069, Rev. 0	Final Hazard Classification for the 105-N and 109-N interim safe storage.
Calculation of Beryllium Content of Zircaloy in Burial Ground 618-7, 0300X-CA-V0030	Calculation that conservatively estimates the beryllium content in Zircaloy chips resulting from N fuel manufacturing process at 2.2% by weight.
Action Plan for Managing Hanford Cultural Resources 100-N Reactor Area, BHI-00710, Draft	Initial draft document provides information regarding cultural resources in the 100-N Reactor area.
Final Hazard Classification and Auditable Safety Analysis for the N Basin Segment, BHI-00968, Rev. 1	The auditable safety analysis for the N Basin segment surveillance and maintenance preceding D4.
Preliminary Hazard Classification for the 105-N and 109-N Zone 1 Segment Intrusive Activities, BHI-01045	This preliminary hazard classification has been superseded by BHI-01179.
105-NE Fission Product Trap and 1305-N Piping Preliminary Hazard Classification, BHI-01110	This preliminary hazard classification has been superseded by BHI-01179.

Table 2-1. Existing Historical References. (4 Pages)

Reference	Summary
Auditable Safety Analysis and Final Hazard Classification for the 105-N Reactor Zone and 109-N Steam Generator Zone Facility, BHI-01179, Rev. 0	This auditable safety analysis provides the authorization basis for the Reactor/Steam Generator Zone Segment and includes activities during both deactivation, and surveillance and maintenance preceding decontamination and decommissioning (D4). This document is also a source of information that can be used to evaluate future decommissioning alternatives.
Data Quality Objective Summary for the 100 Area Burial Grounds and 300-FF-2 Operable Unit Waste Sites, BHI-01501, Rev. 0	Includes a description of how waste will be characterized for waste designation.
Data Quality Objectives Summary Report for D4 Waste Characterization of the 300 Area Buildings, BHI-01750, Rev. 0	Data quality objectives for characterizing waste generated during the D4 of the 300 Area facilities.
Fission Product Trap (FPT) Water Removal, CCN 030417	A comparison of man-hours and man-rem to remove fission product trap pit water in 1996 versus 2006. Estimated 75% reduction in exposure if done in 2006.
Preliminary Hazard Classification for 105 Building Non-Zone 1 Segment, CCN 042838	Preliminary hazard classification for 105-N Building Non-Zone 1 Segment determined that the segment was classified as "Industrial."
C Elevator Pit Contamination Control, CCN 046485	Recommends that the sediment remaining in C elevator pit remain wet until remediation occurs to minimize the potential for airborne contamination.
100N Facility Endpoint Criteria and Turnover Documentation 105-N Lift Station and Valve Pit, No. 0521104	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria have been met.
100N Facility Endpoint Criteria and Turnover Documentation - 105-NE/ 1305-N Fission Products Trap (FPT)/Radioactive Liquid Waste Lines to FPT, No. 0521108	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria have been met.
100N Facility Endpoint Criteria and Turnover Documentation - 105-N Reactor/Process Building (Grade Elevations Non Zone 1), No. 0521109	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria have been met.
100N Facility Endpoint Criteria and Turnover Documentation - 105-N Reactor/Process Building (Below Grade Elevations non Zone 1), No. 0521111	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria have been met.
100N Facility Endpoint Criteria and Turnover Documentation - 105-N Reactor/Process Building (+14' and +28' Elevations non Zone 1), No. 0521112	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria have been met.
100N Facility Endpoint Criteria and Turnover Documentation 105-N Fuel Storage Basin, No. 0521113	The electronic version only contains the checklist portion of the documentation that verifies that all deactivation criteria have been met or lists the exceptions that have not been met. The hard copy files contain all the back-up documentation for showing the endpoint criteria

Table 2-1. Existing Historical References. (4 Pages)

Reference	Summary
	have been met.
100N Facility Endpoint Criteria and Turnover Documentation - 105-N/109-N Zone 1, No. 0521114	Contains documentation of the deactivation of this portion of 105-N/109-N.
100N Facility Endpoint Criteria and Turnover Documentation - 109-N Heat Exchanger Building (Non Zone 1), No. 0521133	Contains documentation of the deactivation of this portion of 109-N.
100N Facility Endpoint Criteria and Turnover Documentation 1722-N Decontamination Building, No. 0521165	Contains documentation of the deactivation of 1722-N.
105-N Reactor Building and 109-N Heat-exchanger Building Action Memorandum, CCN 119850	Documents the regulators approval to D4 portions of the 105-N and 109-N facilities and place them into interim safe storage.
Engineering Evaluation/Cost Analysis for the 105-N Reactor Facility and 109-N Heat Exchanger Building, DOE/RL-2004-46, Rev. 0	Engineering evaluation/cost analysis for 105-N and 109-N, includes list of Waste Information Data System sites associated with 105/109-N, the primary radionuclide that are contaminants of concern, and potential hazardous substances that may be encountered.
Removal Action Work Plan for 105-N/109-N Buildings Interim Safe Storage and Related Facilities, DOE/RL-2005-43, Internal Draft	The removal action work plan establishes the methods and activities to place the 105-N and 109-N facilities into interim safe storage.
RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-1 Operable Unit, Hanford Site, Richland, Washington, DOE/RL-90-22, Rev. 0	Establishes the objectives, procedures, tasks, and schedule for conducting the *Resource Conservation and Recovery Act of 1976* facility investigation/corrective measures study for the 100-NR-1 Source Operable Unit.
Limited Field Investigation Report for the 100-NR-1 Operable Unit Abatement Assessment, DOE/RL-93-80, Rev. 0	Summarizes the data collection and analysis activities conducted during the 100-NR-1 Source Operable Unit limited field investigation and makes recommendations on the continued candidacy of high-priority sites for interim remedial measures.
Surveillance and Maintenance Plan for the 100-N Area Deactivated Facilities, DOE/RL-98-64, Rev. 0	Summarizes surveillance and maintenance requirements for the 100-N deactivated facilities.
Essential Materials Specification Manual N Reactor, DUN-M-42 PT.A	Contains the specifications, procurement, use and control of process materials consumed in the operation of N Reactor including water treatment chemicals, fuel oils (No 1, 2 and 6) and several gases (Cl, He, N).
100-N Technical Manual, HW-69000	Technical manual describing all the systems and equipment for the operation of 100-N Reactor. This or UNI-M-94 are the first documents one should look at for information on 100-N systems or equipment.
N Reactor Materials Manual, HW-79050	The manual is a catalog of the structural materials in contact with the coolants in the primary, secondary, graphite cooling, and injection water systems at N Reactor. Good reference for materials used in valves, piping, etc., at 100-N Rx.
List of 100-N Area Technical Specifications	This is a printout of all technical specifications related to 100-N Area. Excellent reference to identify technical specification document numbers. Can order the documents to obtain good historical information on the materials and construction methods used at 100-N.

Table 2-1. Existing Historical References. (4 Pages)

Reference	Summary
A History of Major Hanford Operations Involving Radioactive Material, PNL-6964	Contains historical information on radioactive material operations at Hanford.
N-Reactor History, RL-GEN-1180 Sup 1	History of N Reactor from conception to electrical power generation.
N Reactor Updated Safety Analysis Report, UNI-M-90	Excellent reference document - discusses how N Reactor conforms to the Nuclear Regulatory Commission "General Design Criteria of Nuclear Power Plants."
N Reactor Plant Manual, UNI-M-94	Describes all the systems and equipment associated with the operation of N Reactor. This manual or HW-69000 should be the first document someone looks at to obtain information on N Reactor.
Manufacturing Process Specification for N Reactor Fuel, WHC-CM-5-20	Provides the manufacturing process specifications for metallic uranium fuel elements fabricated by the co-extrusion process. This document may also be referenced as DUN-5601.
Facility Effluent Monitoring Plan for the N Reactor, WHC-EP-0477	The monitoring plan for N Reactor effluents while the reactor was in standby mode.
100-N Technical Baseline Report, WHC-SD-EN-TI-251	Provides a technical baseline of waste sites located at 100-N Area.
105-N and 109-N Roofs, Limited Asbestos Inspection Summary, CCN 065385	Report on the results of bulk asbestos sampling of the roofs of 105-N and 109-N.
105-N and 109-N Roof Asbestos Report, Revised Table, CCN 065825	Revised table of the one included in CCN 065385.

D4 = deactivation, decontamination, decommissioning, and demolition

2.2 N REACTOR CORE

N Reactor fuel consisted of slightly enriched uranium fuel rods co-extruded with a zirconium alloy cladding. Approximately 16,000 fuel assemblies were loaded into 1,004 zirconium alloy horizontal process tubes running the width of the reactor core. The N Reactor core consists of a lattice arrangement of graphite blocks transected by horizontal channels for the process tubes and control rods and vertical channels for the ball drop system. The graphite core is encased in a thermal shield consisting of 20-cm (8-in.) cast-iron blocks on the front and rear faces and 2.5-cm (1-in.) boron-steel plate on the sides, top, and bottom of the reactor core. The biological shield consists of 102-cm (40-in.) serpentine and iron aggregate concrete on the front and rear faces, 109-cm (43-in.) high-density concrete on the sides, 165-cm (65-in.) high-density concrete on the top, and 258-cm (102-in.) regular concrete on the bottom of the core. The core was surrounded by an aluminum reflector layer. Cooling systems were provided for the process tubes, thermal shield, and horizontal control rods. The reactor core was inerted by either nitrogen (during extended outages) or a helium/carbon dioxide cover gas to control temperature and moisture levels. Table 2-2 shows the estimated radionuclide inventory for each of the main components of the N Reactor core as of March 31, 2005.

Table 2-2. Estimated Radionuclide Inventory for N Reactor Core on March 31, 2005.

Isotope	Graphite Stack Inventory (Ci)	Thermal and Biological Shield Inventory (Ci)	Process Tubes and Control System Inventory (Ci)	Total Inventory (Ci)
H-3	3.49E+04	--	--	3.49E+04
C-14	9.55E+03	--	--	9.55E+03
Cl-36	7.50E+01	--	--	7.50E+01
Ca-41	1.00E+00	2.00E+01	--	2.10E+01
Ni-59	--	1.20E+01	1.21E+04	1.21E+04
Co-60	4.63E+00	1.58E+04	3.63E+03	1.96E+04
Ni-63	1.43E+01	1.52E+03	1.08E+02	1.63E+03
Sr-90	1.18E+01	--	8.19E+00	1.99E+01
Y-90	1.18E+01	--	8.19E+00	2.00E+01
Mo-93	--	7.99E-02	--	7.99E-02
Zr-93	--	--	1.14E+02	1.14E+02
Nb-93m	--	2.37E-02	3.35E+01	3.35E+01
Nb-94	1.50E+00	8.00E-02	--	1.58E+00
Tc-99	--	4.00E-03	--	4.00E-03
Ag-108	--	5.04E-02	--	5.04E-02
Ag-108m	--	5.60E-01	--	5.60E-01
Cs-137	3.39E+01	--	3.59E+00	3.75E+01
Eu-152	4.58E+01	--	4.71E+01	9.29E+01
Eu-154	1.77E+01	--	3.71E+01	5.48E+01
U-235	1.00E-08	--	--	1.00E-08
Np-237	9.34E-07	--	--	9.34E-07
Pu-239	1.40E+00	--	--	1.40E+00
Am-241	3.95E-01	--	--	3.95E-01
Total	**4.47E+04**	**1.73E+04**	**1.62E+04**	**7.83E+04**

The charging elevator (C Elevator) is located on the front face of the N Reactor. Beneath the C Elevator is a 4.6-m by 12.8-m by 5.2-m (14-ft by 39-ft by 16-ft)-deep elevator pit. Contaminated water and sediments from the reactor coolant drained into the C Elevator Pit when the process tubes were opened during refueling. The C Elevator Pit contains contaminated debris beneath several feet of water. The water provides shielding and prevents the approximately 8-cm (3-in.) layer of contaminated sediments from drying out and becoming airborne. Table 2-3 shows the estimated radionuclide inventory for the C Elevator Pit as of March 31, 2005.

Table 2-3. Estimated Radionuclide Inventory for C Elevator Pit on March 31, 2005.

Isotope	Water Inventory (Ci)	Sediment (Ci)	Total Inventory (Ci)
H-3	6.37E+00	--	6.37E+00
C-14	8.38E-03	--	8.38E-03
Fe-55	5.74E-05	--	5.74E-05
Co-58	7.73E-12	--	7.73E-12
Co-60	2.53E-04	3.13E+00	3.13E+00
Ni-63	3.85E-03	--	3.85E-03
Sr-90	1.71E+00	1.08E+01	1.25E+01
Y-90	1.71E+00	1.08E+01	1.25E+01
Tc-99	9.10E-04	6.06E-02	6.15E-02
Sb-125	4.79E-04	2.46E-02	2.51E-02
I-129	3.21E-04	--	3.21E-04
Cs-134	1.14E-04	4.65E-03	4.77E-03
Cs-137	3.77E-01	1.32E+01	1.36E+01
Eu-152	9.67E-04	--	9.67E-04
Eu-154	6.55E-05	2.20E-01	2.20E-01
Eu-155	3.17E-04	9.64E-02	9.67E-02
Ra-226	1.12E-05	3.52E-01	3.52E-01
Th-232	7.96E-27	1.62E-13	1.62E-13
U-234	6.16E-09	6.96E-03	6.96E-03
U-235	1.62E-11	1.67E-04	1.67E-04
U-236	1.03E-16	7.14E-04	7.14E-04
U-238	--	3.20E-03	3.20E-03
Np-237	1.00E-05	4.36E-06	1.44E-05
Pu-238	4.62E-04	4.19E-01	4.19E-01
Pu-239	3.54E-03	2.56E+00	2.56E+00
Pu-241	--	1.02E+02	1.02E+02
Pu-242	--	5.12E-03	5.12E-03
Am-241	1.33E-04	3.30E+00	3.30E+00
Cm-242	4.14E-10	--	4.14E-10
Am-243	--	4.73E-07	4.73E-07
Cm-243	--	3.42E-01	3.42E-01
Cm-244	2.75E-06	--	2.75E-06
Total	**1.02E+01**	**1.47E+02**	**1.57E+02**

2.3 N REACTOR COOLING SYSTEMS

N Reactor generally operated at about 4,000 megawatts thermal power. To control core temperatures, the core was cooled by a closed-loop primary coolant system. The primary coolant system was composed of high-purity water pressurized and pumped through the process tubes and around the fuel assemblies to remove heat from the fission process. The primary coolant was then circulated from the process tubes in the reactor to heat exchangers (steam generators) located in the 109-N Heat Exchanger Building. Process heat was transferred from the primary coolant system to the secondary coolant system in 12 steam generators located in 6 shielded cells in the 109-N Building. As the water reached boiling temperatures, steam was produced in the closed-loop secondary cooling system. Some of this steam was used to drive N Reactor's primary coolant pumps. A portion of the steam was used to generate electric power for use within the reactor plant. When N Reactor was operating in a plutonium-only mode, the balance of the steam was dissipated in the dump heat condensers located in the 109-N Building. When N Reactor was operating in a dual-purpose mode, the steam was used to drive the two large turbine generators producing approximately 860 megawatts of electricity.

The primary coolant system was supplied by the demineralized water with chemicals added for water quality control. Chemicals added to the coolant system were ammonium hydroxide and hydrazine for pH and oxygen control respectively. The primary coolant system became radiological contaminated with radionuclides produced by activation of materials in the system. Table 2-4 shows the estimated radiological inventory for the residue and activated materials in the primary coolant piping system as of March 31, 2005.

Table 2-4. Estimated Inventory of the N Reactor Primary Coolant Piping on March 31, 2005.

Isotope	Total (Ci)
Co-60	6.06E+02
Sr-90	1.03E+02
Y-90	1.03E+02
Cs-137	4.52E+01
Eu-152	5.93E+02
Eu-154	4.67E+02
Total	**1.92E+03**

The secondary coolant system was supplied by demineralized water with morpholine and hydrazine added for pH and oxygen control respectively. Periodic leaks in the steam generator heat exchanger tubing caused the secondary coolant system to be radiologically contaminated with radioactivity from the primary coolant system.

There were two additional reactor periphery cooling systems: graphite and shield cooling and reactor control rod cooling. These were closed-loop systems using demineralized water. Ammonium hydroxide and hydrazine were added to the graphite and shield cooling water for pH and oxygen control respectively. Hydrazine was added to the reactor control rod cooling water for oxygen control.

2.4 N REACTOR FUEL STORAGE BASIN

About every 6 weeks, 20% to 30% of the N Reactor fuel was discharged. When it was time to discharge irradiated fuel, the reactor was shut down. As new fuel was pushed into a process tube at the front face of the reactor, spent fuel was discharged at the rear face of the reactor. One by one, fuel assemblies would fall onto a trampoline and then into carts under water to transport the fuel to the fuel storage basin. During the fuel discharge and transfer process, a large quantity of reactor primary coolant water, containing a considerable amount of suspended and soluble metals and metal oxides, was added to the fuel storage basin water.

The fuel would remain under water in the fuel storage basin for approximately 180 days to dissipate its heat and radioactivity to allowable levels. The water served as a highly effective shield to protect workers from heat and radioactivity. After approximately 180 days, the fuel was loaded into fuel storage canisters and then into lead-shielded transport casks for processing.

In 1998, the N Reactor fuel storage basin was cleaned out and interim stabilized. Contaminated hardware and equipment, sludge, fuel pieces, and contaminated water were removed from the fuel storage basin. Steel plates were put over the fuel handling cubicles, and the entire basin was covered with concrete blocks to provide shielding and isolation. A small amount of debris and sediment remains in the basin that will need to be removed. A 0.3-m (1-ft) layer of water remains in the north cask loadout pit for shielding. The basin concrete surfaces also remain contaminated.

Table 2-5 shows the estimated radionuclide inventory for the main constituents of the N Reactor fuel storage basin as of March 31, 2005.

Table 2-5. Estimated Radionuclide Inventory for the N Reactor Fuel Storage Basin on March 31, 2005. (2 Pages)

Isotope	Debris (Ci)	Water (Ci)	Sediment (Ci)	Walls and Floor (Ci)	Total Inventory (Ci)
H-3	--	6.28E-01	--	6.36E+02	6.37E+02
C-14	7.26E-01	9.26E-04	--	9.38E-01	1.67E+00
Mn-54	1.46E-04	--	--	--	1.46E-04
Fe-55	1.77E+01	3.74E-06	--	3.79E-03	1.77E+01
Co-58	--	5.75E-16	--	5.80E-13	5.80E-13
Co-60	2.33E+01	2.14E-05	9.07E-01	4.78E+00	2.89E+01
Ni-59	1.92E+01	--	--	--	1.92E+01
Ni-63	1.78E-01	4.20E-04	--	4.25E-01	6.03E-01
Sr-90	3.76E-01	1.80E-01	3.88E+00	2.03E+02	2.07E+02
Y-90	3.76E-01	1.80E-01	3.88E+00	2.03E+02	2.07E+02
Zr-93	1.86E-02	--	--	--	1.86E-02
Nb-93m	5.68E-02	--	--	--	5.68E-02
Tc-99	--	1.01E-04	2.29E-02	2.22E-01	2.45E-01
Sb-125	4.34E-05	3.14E-05	5.52E-03	6.08E-02	6.64E-02

Table 2-5. Estimated Radionuclide Inventory for the N Reactor Fuel Storage Basin on March 31, 2005. (2 Pages)

Isotope	Debris (Ci)	Water (Ci)	Sediment (Ci)	Walls and Floor (Ci)	Total Inventory (Ci)
Te-125m	1.06E-05	7.67E-06	1.35E-03	1.49E-02	1.62E-02
I-129	--	3.55E-05	--	5.59E-02	5.59E-02
Cs-134	--	6.33E-06	8.85E-04	1.10E-02	1.19E-02
Cs-137	1.65E-01	3.98E-02	4.76E+00	6.53E+01	7.03E+01
Ba-137m	1.56E-01	3.77E-02	4.50E+00	6.18E+01	6.65E+01
Eu-152	--	9.58E-05	--	9.72E-02	9.73E-02
Eu-154	1.22E-02	6.15E-06	7.08E-02	3.77E-01	4.60E-01
Eu-155	9.05E-04	2.64E-05	2.74E-02	1.71E-01	1.99E-01
Ra-226	4.18E-16	1.25E-06	1.33E-01	7.00E-01	8.33E-01
Th-232	--	2.59E-27	8.86E-14	4.66E-13	5.54E-13
U-234	1.48E-08	9.75E-10	2.63E-03	1.38E-02	1.64E-02
U-235	2.77E-11	2.58E-12	6.32E-05	3.32E-04	3.95E-04
U-235m	4.21E-03	3.92E-04	9.68E-01	5.49E+00	6.46E+00
U-236	--	2.32E-17	2.70E-04	1.42E-03	1.69E-03
U-238	--	--	1.21E-03	6.37E-03	7.58E-03
Np-237	5.87E-09	1.11E-06	2.52E-06	1.13E-03	1.14E-03
Pu-238	7.64E-04	5.03E-05	1.56E-01	8.71E-01	1.03E+00
Pu-239	4.21E-03	3.92E-04	9.68E-01	5.49E+00	6.46E+00
Pu-241	5.08E-02	--	3.49E+01	1.83E+02	2.18E+02
Pu-242	--	--	1.93E-03	1.02E-02	1.21E-02
Am-241	3.00E-03	1.47E-05	1.37E+00	7.19E+00	8.56E+00
Am-243	--	--	2.52E-07	1.32E-06	1.58E-06
Cm-242	--	1.91E-12	--	1.93E-09	1.93E-09
Cm-243	--	--	1.23E-01	6.48E-01	7.71E-01
Cm-244	--	2.81E-07	--	2.84E-04	2.85E-04
Total	**6.23E+01**	**1.07E+00**	**5.66E+01**	**1.38E+03**	**1.50E+03**

2.5 NON-ZONE 1 PORTIONS OF N REACTOR

Much of the 105-N and 109-N Buildings are outside of radiologically controlled contamination areas. These areas are referred to as the non-zone 1 portions of N Reactor and contain much lower levels of radiological contamination. Table 2-7 shows the estimated radionuclide inventory for the non-zone 1 portion of N Reactor as of March 31, 2005.

Table 2-6. Estimated Radionuclide Inventory for the Non-Zone 1 Portions N Reactor on March 31, 2005.

Isotope	-16 ft Elevation (Ci)	0 Through 51 ft Elevation (Ci)	60 ft Elevation (Ci)	Total Inventory (Ci)
Co-60	1.20E-03	9.66E-02	2.41E-03	1.00E-01
Sr-90	2.63E-05	2.62E-04	3.04E-04	5.92E-04
Y-90	2.63E-05	2.62E-04	3.04E-04	5.92E-04
Nb-93m	2.62E-02	--	--	2.62E-02
Ru-106	6.89E-08	1.71E-07	1.30E-07	3.71E-07
Sb-125	2.23E-05	5.70E-05	4.30E-05	1.22E-04
I-129	7.31E-06	5.80E-05	2.54E-04	3.19E-04
Cs-134	9.35E-07	2.49E-06	1.90E-06	5.33E-06
Cs-137	1.09E-04	1.17E-02	1.97E-04	1.20E-02
Eu-154	2.69E-02	--	2.59E-03	2.95E-02
Eu-155	5.09E-03	--	8.42E-04	5.93E-03
Ra-226	2.25E-18	1.31E-17	2.44E-17	3.97E-17
Th-232	2.23E-22	1.16E-21	1.58E-21	2.97E-21
U-234	5.09E-11	2.97E-10	5.52E-10	9.00E-10
U-235	6.21E-08	1.50E-06	9.97E-07	2.56E-06
U-236	1.09E-12	5.69E-12	7.72E-12	1.45E-11
U-238	3.57E-16	2.72E-15	3.28E-15	6.36E-15
Np-237	2.76E-07	2.10E-06	2.54E-06	4.92E-06
Pu-238	2.09E-06	1.22E-05	2.27E-05	3.69E-05
Pu-239	4.41E-06	2.30E-05	3.13E-05	5.87E-05
Pu-241	5.46E-05	8.09E-04	6.82E-04	1.55E-03
Pu-242	2.76E-07	2.10E-06	2.54E-06	4.92E-06
Am-241	4.35E-06	4.28E-05	3.80E-05	8.52E-05
Am-243	1.02E-11	3.40E-10	3.06E-11	3.81E-11
Cm-243	2.93E-06	1.31E-04	1.18E-05	1.45E-04
Cm-244	1.19E-06	1.09E-04	9.59E-06	1.20E-04
Total	**6.23E+01**	**1.07E+00**	**1.38E+03**	**1.50E+03**

2.6 REACTOR DECONTAMINATION

N Reactor systems and equipment were periodically decontaminated to reduce radioactive contamination levels and associated dose levels. Every 3 to 5 years, the reactor primary coolant loop was decontaminated with a 70% phosphoric acid/diethylthiourea solution diluted to an 8% solution by weight. The solution was mixed in the 109-N Building and pumped through the reactor primary cooling system to remove radioactive oxides (containing activation and fission products) that had built up as residues in the piping and valves. The decontamination solution and rinsate was pumped through the system and into the 1310-N Storage Tank for disposal as low-level waste.

Other N Reactor systems and equipment were periodically decontaminated. The steam generator equipment was periodically decontaminated with alkaline potassium permanganate and citric oxalic acid. Ascorbic and citric acid were used to decontaminate the reactor process tube caps and inserts as well as miscellaneous hand tools. Contaminated tools were also decontaminated using 1,1,2-trichloro-1,1,2-trifluoroethane.

2.7 AIRBORNE RELEASES

The N Reactor had five ventilation zones (confinement zones), each served by supply and exhaust fan units, and plenums connected to duct work containing dampers and supply grilles. The purpose of this system was to set up zones to prevent the spread of radioactive contamination and to provide a controlled environment for personnel comfort, optimum machinery performance, instrument reliability, and concrete stability. Air exhausted from zones 1 and 2 was routed through the 117-N Filter Building. The 117-N facility housed a HEPA filter and activated charcoal filters used to remove radioactive particulates and iodine-131 from the exhaust air. The facility also housed a water-spray system that automatically activated if a high-temperature excursion was detected. After filtration, the exhaust was routed to the 116-N Exhaust Air Stack and vented to the atmosphere. Table 2-8 shows contamination levels measured in the 117-N and 116-N facilities in 1998.

Table 2-7. Contamination Level in the 117-N and 116-N Facilities in 1998.

Loading (Ci)	117-N Filter Building	116-N Exhaust Stack
Smearable Contamination	0.0030	0.00027
Fixed Contamination	0.0016	0.0050
Total Loading	**0.0046**	**0.0053**

2.8 SOLID WASTE

Reactor solid wastes generally consisted of reactor components, contaminated equipment, tools, and miscellaneous contaminated items (e.g., paper, rags, construction and repair debris, personal protective equipment). The main source of these wastes was reactor operations, and the most highly contaminated solid wastes were reactor components. The N Reactor solid wastes were packaged and transported to other locations, either 200 Area burial grounds or other 100 Area burial grounds, for disposal. During deactivation, all solid waste materials not attached to the facility were removed and disposed.

Table 2-8 contains supporting documentation and resources related to waste disposition and handling for the N Reactor facilities in the scope of the data quality objectives document.

Table 2-8. Supporting Waste Disposition Documentation. (2 Pages)

Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N001 Rev. 00 through Rev. 10	Waste profile for 100-N Area miscellaneous materials.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N002 Rev. 00	Waste profile for 100-N Area miscellaneous wastes containing macroencapsulated lead.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N003 Rev. 00	Waste profile for N Basin Sediment. Incorporates calculation 0100N-CA-N0038, *Characterization of Mixed Sediment in North Cask Pit and Basin Water.*
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N004 Rev. 00	Waste profile for N Basin miscellaneous materials.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N005 Rev. 00	Waste profile for N Basin miscellaneous materials containing lead.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N007 Rev. 00	Waste profile for 11-N, 13-N, 1714-N, -NA, NB, and 1712-N. Paints and other waste from these facilities would be similar to some of the wastes generated at 105-N/109-N facilities.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP100N008 Rev. 00	Waste profile for 100-N Area miscellaneous materials. Waste profile for specific stream of waste containing "Quik Tred Deep Base (MSDS 027091) and floor sweep (MSDS 062229).
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP105N001 Rev. 00	Waste profile for 105-N and 109-N roofing.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP107N001 Rev. 0	Waste profile for 107-N miscellaneous debris. Wastes from this facility would be similar to some of the wastes generated during D4 of the 105-N/109-N facilities.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP1300N001 Rev. 0 through Rev. 3	Waste profile for 1300-N Emergency Dump Basin waste. Wastes from this facility would be similar to some of the wastes generated during D4 of the 105-N/109-N facilities.
Environmental Restoration Disposal Facility Waste Profile Data Sheet, WP1304N001 Rev. 0 and Rev. 1	Waste profile for 1304-N Emergency Dump Tank. Wastes from this facility would be similar to some of the wastes generated during D4 of the 105-N/109-N facilities.
Activity Conversion Factors for 100-N Facilities, 0100N-CA-N0018	Calculates the radioactivity conversion factors for estimating radionuclide surface or mass specific radioactivity concentrations in selected 100-N facility areas/equipment based on in-plant dose rate measurements.
Radionuclides in 105-NE, 1305-N, and 1304-N, 0100N-CA-N0025	Calculates the radioactive material inventory in the 105-NE Fission Products Trap, associated 1305-N piping, and the 1304-N Emergency Dump Tank.
Residual Radioactive Inventory After N Basin Cleanup, 0100N-CA-N0045	Calculates inventory of residual radioactive material remaining in N Basin at end of deactivation.
Radionuclide Inventory in 117N Building and 116N Stack, 0100N-CA-N0048	Calculates the total curies of radioactivity in the 117-N and 116-N facilities, based on radiological survey data taken in 1997 and 1998.
105-N Reactor Building Residual Radioactivity Estimate, 0100N-CA-N0049	Calculates the total residual radioactivity in the 105-N Reactor structure (decayed to 1997).
C Elevator Pit Curie Content, 0100N-CA-N0057	Engineering calculation of the amount of radioactive material in the C elevator pit in 105-N. Calculation uses 105-N Basin water and sediment radionuclides and activities.

Table 2-8. Supporting Waste Disposition Documentation. (2 Pages)

Limited Field Investigation Report for the 100-NR-1 Operable Unit Abatement Assessment, DOE/RL-93-80	Summarizes the data collection and analysis activities conducted during the 100-NR-1 Source Operable Unit limited field investigation and makes recommendations on the continued candidacy of high-priority sites for interim remedial measures.
Essential Materials Specification Manual N Reactor, DUN-M-42 PT.A	Provides the specifications, procurement, use and control of process materials consumed in the operation of N Reactor including water treatment chemicals, fuel oils (No 1, 2, and 6) and several gases (Cl, He, N).
N Reactor Materials Manual, HW-79050	The manual is a catalog of the structural materials in contact with the coolants in the primary, secondary, graphite cooling, and injection water systems at N Reactor.

D4 = deactivation, decontamination, decommissioning, and demolition
MSDS = material safety data sheet

3.0 INTERIM SAFE STORAGE CONCEPT AND RECOMMENDATIONS FOR THE N REACTOR COMPLEX

The ISS of the N Reactor complex will consist of performing D4 on portions of the 105-N Reactor Building and the 109-N Heat Exchanger Building as described in this section. The goal of ISS will be to cost-effectively ensure durable and long-term facility storage in a manner that is protective of human health and the environment. The ISS alternative will be implemented as described in the following subsections. Limited S&M of the 105-N and 109-N SSEs will follow ISS activities. Demolition of the remaining portions of 109-N (piping gallery and steam generator cells) will be performed after the long-term S&M period in the 2068 time frame and prior to graphite removal.

ISS of 105-N and 109-N will consist of performing D4 of portions of the 105-N/109-N facilities and construction of an SSE over the 105-N Reactor block and the 109-N steam generator cells, pipe gallery, and the penthouse structure surrounding the pressurizer tank. The 109-N facility is being considered for ISS with the 105-N facility because contact with the primary reactor coolant within the 109-N piping systems and steam generator cells resulted in high levels of radionuclide contamination in the 109-N facility, and due to concerns over the structural integrity of separating the two facilities. ISS will prevent advanced structural deterioration and potential release of radionuclides or other hazardous substances. Figures 3-1 and 3-2 provide a depiction of the N Reactor complex before and after completion of the ISS Project.

Figure 3-1. Aerial Photograph of the N Reactor Complex during Operation (~1985).

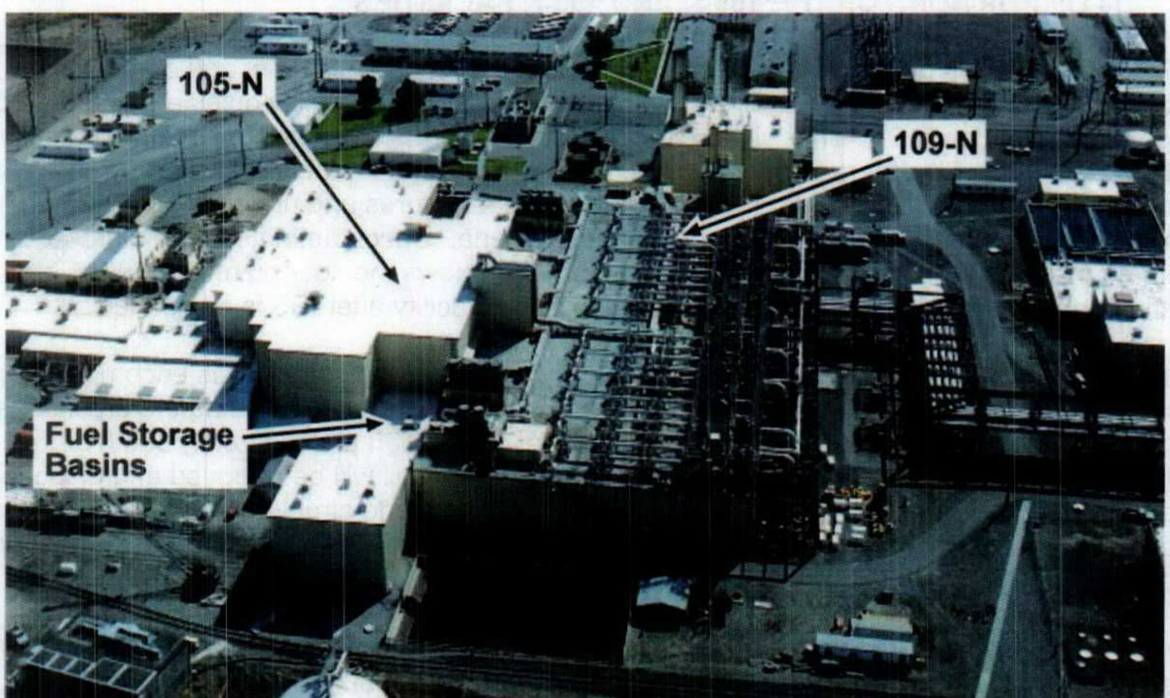
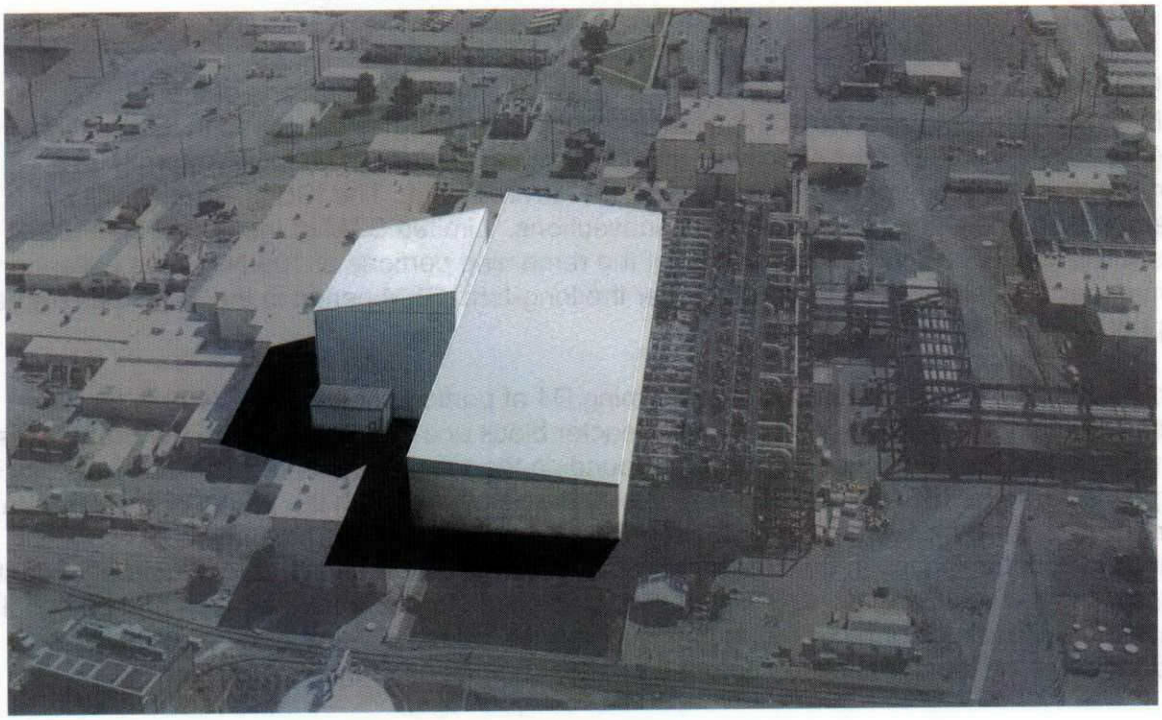


Figure 3-2. Conceptual Diagram of the N Reactor Complex after Interim Safe Storage of the 105-N and 109-N Facilities.



3.1 D4 OF PORTIONS OF THE 105-N AND 109-N FACILITIES

The first stages of this process will consist of assessment, decontamination, and demolition of portions of the 105-N and 109-N facilities. All portions of the 105-N facility outside of the reactor shield walls will undergo D4. This will also include the 105-N Fuel Storage Basin and loadout facilities. Removal of the storage basins will result in a significant reduction of radiological contamination in the facility. Contaminated below-grade structures and underlying soil will be removed and disposed, as needed, to meet cleanup criteria. Uncontaminated below-grade structures may be stabilized and left in place. Figure 2-2 shows the floor plan of the 0-ft elevation and identifies the reduced footprint of the 105-N facility after ISS is completed.

For the 109-N facility, all portions of the 109-N facility outside of the shield walls encompassing the steam generator cells, pipe gallery, and the penthouse structure surrounding the pressurizer tank will undergo D4. This includes the external steam distribution piping directly south of the facility. Contaminated below-grade structures and underlying soil will be removed and disposed, as needed, to meet cleanup criteria. Uncontaminated below-grade structures may be stabilized in place. Figure 2-3 shows the floor plan of the 0-ft elevation and identifies the reduced footprint of the 109-N facility after ISS is completed.

Assessment will consist of radiological surveys and sampling, characterization, and preparation of all engineering and safety documents and work packages to perform the field activities.

Decontamination could be accomplished through a variety of methods, such as scrabbling or scaling as may be needed to allow open air demolition. In general, when physical removal of contaminants is not feasible or cost effective or of a deminimus nature that does not challenge any regulatory limits, the contamination will be "fixed" so that the contaminants will remain attached to the construction materials and will be less likely to be disturbed during subsequent demolition activities. Methods of fixing contaminants in place include painting, applying asphalt, and spreading plastic sheeting.

Facility decontamination will be used to ensure worker safety by radiation as low as reasonable achievable (ALARA) that minimizes potential exposure during D4. Decontamination will also reduce the potential for contaminated fugitive emissions. In addition, decontamination will reduce the protection required during D4, thus reducing overall removal and disposal costs.

After decontamination processes are completed, facility components, piping, ducting, and equipment may be dismantled and removed for disposal. Demolition generally means large-scale facility destruction using heavy equipment (e.g., wrecking ball, excavator with a hoe-ram, shears, and concrete pulverizer), explosives, or other industrial methods. Demolition methods will be selected based on the structural elements to be demolished, remaining radionuclide contamination, location, and integrity of the facility structure. Dust-suppression techniques will be employed during all demolition activities.

3.1.1 Fuel Storage Basin

The 105-N Fuel Storage Basin presents unique challenges for the ISS process at 100-N when compared to the other five Hanford Site reactors that have preceded it. The primary reason for the challenge is the remaining source term in the basin due to a combination of time since reactor shutdown (about 20 years for N Reactor versus approximately 32 years for some of the other reactors) and the very different fuel designs and burn-up that was used in the N Reactor.

The path forward for the 105-N Fuel Storage Basin noted in Section 1.3 is expected to result in an inspection/investigation and calculation phase to refine both the physical and radiological conditions of the basin floor. By collecting newer data and redefining the basin source term from that presented in Table 2-5, the project may be able to include the open air demolition of the basin in a revision to the project's *Removal Action Work Plan for 105-N/109-N Buildings Interim Safe Storage and Related Facilities* (DOE-RL 2006).

If the definition of a more accurate source term does not result in allowing open air demolition, the existing source term must be removed or encapsulated prior to demolition. Either of these latter options will require extensive planning beyond the scope of this document.

3.1.2 Safe Storage Enclosure

Deactivation of the SSE portion of 105-N/109-N has been completed by a previous contractor (see BHI 1995 and BHI 1998). Because of the high levels of radiation associated with the primary coolant loop, no entry will be made into the 105-N Reactor block room, 109-N steam generator cells, pipe gallery, and pressurizer room due to ALARA considerations. The dangerous waste has already been removed from these areas, as documented by WCH (1993) and BHI (1995). The associated asbestos insulation will be left in place, including the reactor inlet and outlet piping located in the front- and rear-face rooms. This will have no impact on construction of the SSE or S&M activities to follow, as these rooms will not be part of the S&M walkdown path. Hazardous material removal (e.g., lead not providing shielding, asbestos abatement, light ballast removal, and draining oil from motors) will be conducted in the remaining portions of the 105-N/109-N SSE.

3.2 CONSTRUCTING THE SAFE STORAGE ENCLOSURES ON THE 105-N AND 109-N FACILITIES

The 105-N/109-N SSE design will "enclose" the reactor block and the steam generator cells, leaving only the high-radiation portions of the facilities with very limited access. All surveillance paths into the SSE will be through high-radiation areas. Necessary ventilation ducting will be installed inside the SSE that will be connected to an external port, allowing the use of a portable exhaust unit if required. A remote monitoring system with primary and backup sensors for each monitor point will be installed inside the reactor enclosure so that key parameters can be monitored. The equipment associated with monitoring and electrical power and lighting will be installed in a utility room located outside of the SSE so that entry into the SSE will not be necessary to service this portion of the equipment or change to a backup sensor if the primary unit fails. If the remote monitoring equipment records a problem within the enclosure that requires physical inspection within the enclosure, an emergency condition occurs, or servicing the remote sensors is required, provisions will be incorporated into the SSE design to facilitate these entries on a very limited basis.

3.3 LONG-TERM SURVEILLANCE AND MAINTENANCE OF THE SAFE STORAGE ENCLOSURE STRUCTURES

Long-term S&M will be required only for the SSE structures. The monitoring following ISS will be accomplished remotely, and maintenance activities will be performed on the SSE exterior (e.g., roof inspections, structural integrity inspections, and external radiological surveys). By design, the SSE structure will require minimal surveillance. It will be equipped with remote monitoring equipment that allows surveillance of key parameters (humidity and temperature) within the enclosure. The design of the SSE will be such that no significant maintenance will be required.

Remote monitoring data evaluations will be routinely performed to ensure there is no water or biological intrusion or spread of contamination.

Entry into the facility will occur only if one of the remote monitors indicated a system failure, emergency conditions warranted entry, or the remote monitoring system recorded a problem that required physical inspection. For the purposes of this document, the schedule for disposition of the 105-N Reactor block is assumed to be consistent with the other eight Hanford Site reactors. The *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) calls for final disposition of the eight surplus Hanford Site reactors to be accomplished by 2068. Therefore, S&M will be assumed to occur until final disposition of the reactor block.

4.0 CONCEPTUAL SAFE STORAGE ENCLOSURE DESIGN AND RECOMMENDATIONS

4.1 SAFE STORAGE ENCLOSURE CONCEPTUAL DRAWINGS AND CALCULATIONS

Conceptual drawings and design calculations have been completed. Sketches representing the conceptual drawings are included in Appendix A. The calculations to support the conceptual design are included in Appendix B.

4.2 DESIGN CONSIDERATIONS AND RECOMMENDATIONS FOR SAFE STORAGE ENCLOSURE

4.2.1 Safe Storage Enclosure Design Considerations

The SSE structures will be designed and built to completely enclose the roof sections of the 105-N and 109-N facilities. The SSE will consist of a self-supporting, structural-steel frame covered with metal roofing. Side panels above the shield walls will be covered with metal siding. All openings and penetrations within the shield walls and on top of the reactor will be closed. Large openings will be sealed by concrete pourbacks or steel plates, and welded caps or plugs will close smaller openings and penetrations.

For the 109-N facility, the existing steam generator/pipe gallery shield walls and roof, constructed of 1.5-m (5-ft)-thick reinforced concrete, will be used as the primary enclosure for safe storage. After D4 of the 109-N facility turbine drive bay, steam and cooling water distribution piping, and decontamination cell, a new metal roof will be constructed to enclose the top of the remaining structure along with the pressurizer penthouse area. The roof will consist of structural steel and metal roof decking designed to meet the ISS storage period (the roof has a 75-year design life). The steam generator/pipe gallery walls will support the roof. Openings between the new roof and top of the steam generator/pipe gallery walls will be enclosed with wall panel siding similar to that on the new roof. Openings and penetrations within the steam generator/pipe gallery walls will be closed. Large openings will be sealed by concrete pourbacks, and welded caps or plugs will close smaller openings and penetrations.

4.2.2 Design Recommendations for the Safe Storage Enclosure

For the 105-N and 109-N Buildings, the following design recommendations are made based on the lessons learned from previous SSE design and construction work.

A. For 105-N, do not remove the insulating concrete on the roof. This will act as a platform to place the purlins and metal deck.

   1. This process will reduce fall protection measures while reducing the cost of removal of existing foam and insulating concrete and decking.

   2. This method will also reduce construction cost and time.

B. Use a flat slope of ¼:12, instead of 2:12 to achieve the following advantages:

1. Complies with IBC (2003), Section 1507.4.2.
2. Reduce fall protection measures.
3. Constructor will be able to build the roof virtually standing on the existing roof.
4. Column sizes can be reduced to TS4x4 from TS6X6.
5. This slope will eliminate girts for the siding.
6. Will require less siding.
7. Saving in construction cost and time.

C. The recommended siding and roofing materials for the SSE consist of a standing seam metal roof as was used on previous SSE constructions. This material provides the following advantages:

1. 20-year life with little or no maintenance is customary.
2. Life expectancy on a high-content zinc or copper roof could reach 60 years and beyond.
3. Roof weight is as little as 7.3 kg/m2 (1.5 lb/ft2).
4. Seams are only 2.5 cm (1 in.) or 3.8 cm (1.5 in.) high.

5.0 REFERENCES

58 FR 48509, "Record of Decision: Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, Environmental Impact Statement," *Federal Register*, Vol. 58, p. 48509 (September 16).

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

BHI, 1995, *N Reactor Deactivation Program Plan*, BHI-00075, Rev, 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998, *N Area Final Project Program Plan*, BHI-01130, Rev, 0, Bechtel Hanford, Inc., Richland, Washington.

DOE, 1989, *Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *Draft Environmental Impact Statement; Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119D, U.S. Department of Energy, Washington D.C.

DOE, 1992, *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119F, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1994, *Closure Report for N Reactor*, DOE/RL-91-59, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. (Regarding N Reactor, see page 1-1)

DOE-RL, 2004, *Engineering Evaluation/Cost Analysis for the 105-N Reactor Facility and the 109-N Heat Exchanger Building*, DOE/RL-2004-46, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2006, *Removal Action Work Plan for 105-N/109-N Buildings Interim Safe Storage and Related Facilities*, DOE/RL-2005-43, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, DOE, 1999, *Action Memorandum for the 100-N Ancillary Facilities*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, 2005, *105-N Reactor Building and 109-N Heat-Exchanger Building Action Memorandum*, LTR 0500979, from Michael A. Wilson to Keith A. Klein, U.S. Department of Energy, Richland Operations Office, dated February 22, 2005, Washington State Department of Ecology, Olympia Washington.

IBC, 2003, *International Building Code*, International Codes Council, Falls Church, Virginia.

National Environmental Policy Act of 1969, 42 U.S.C. 4321, et seq.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 9601, et seq.

Superfund Amendments and Reauthorization Act of 1986, 42 U.S.C. 9601, et seq.

WHC, 1993, *N Reactor Deactivation Program Plan*, WHC-SP-0615, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

FIGURES

APPENDIX A

FIGURES

Figure A-1.

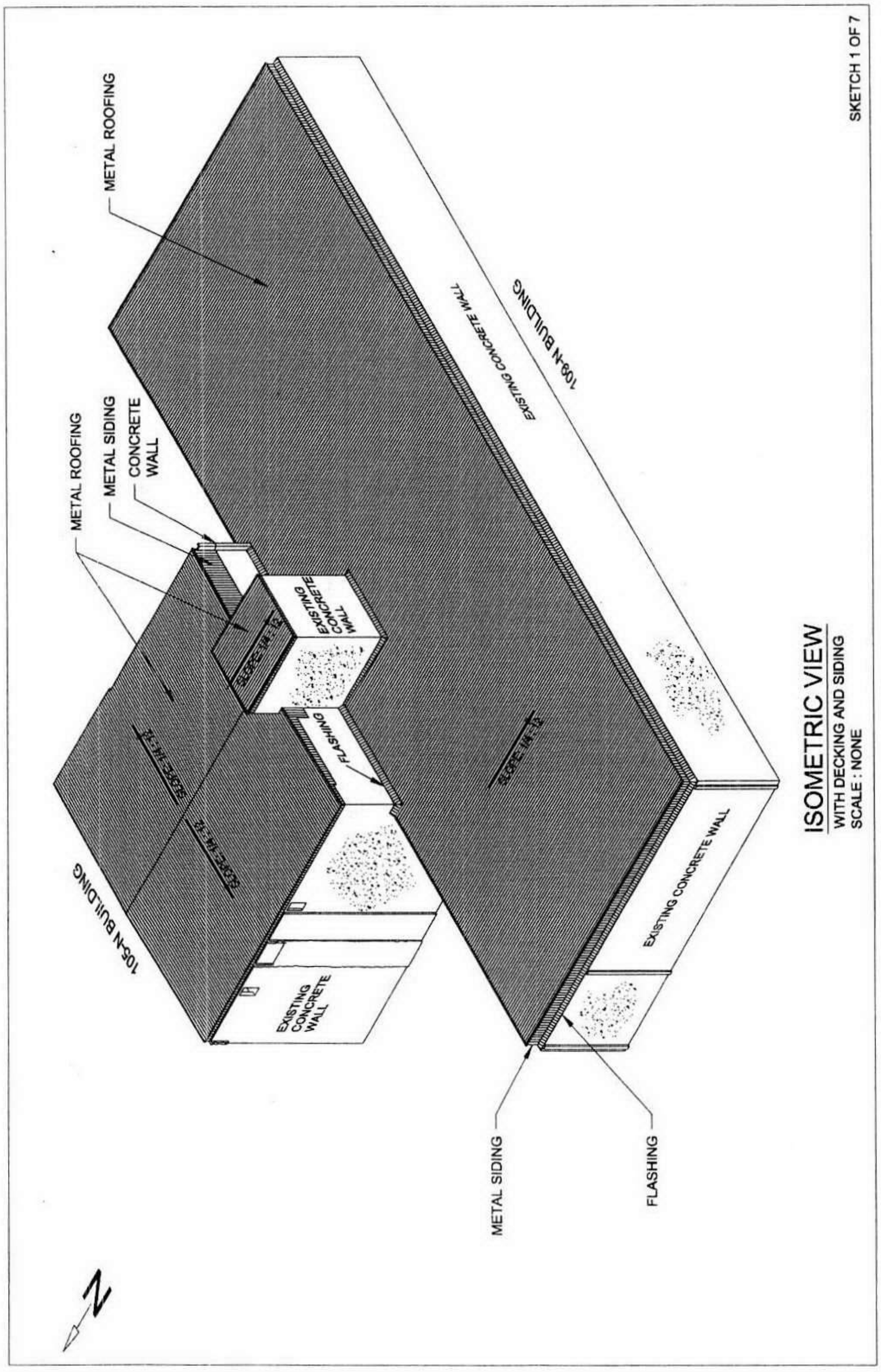


Figure A-2.

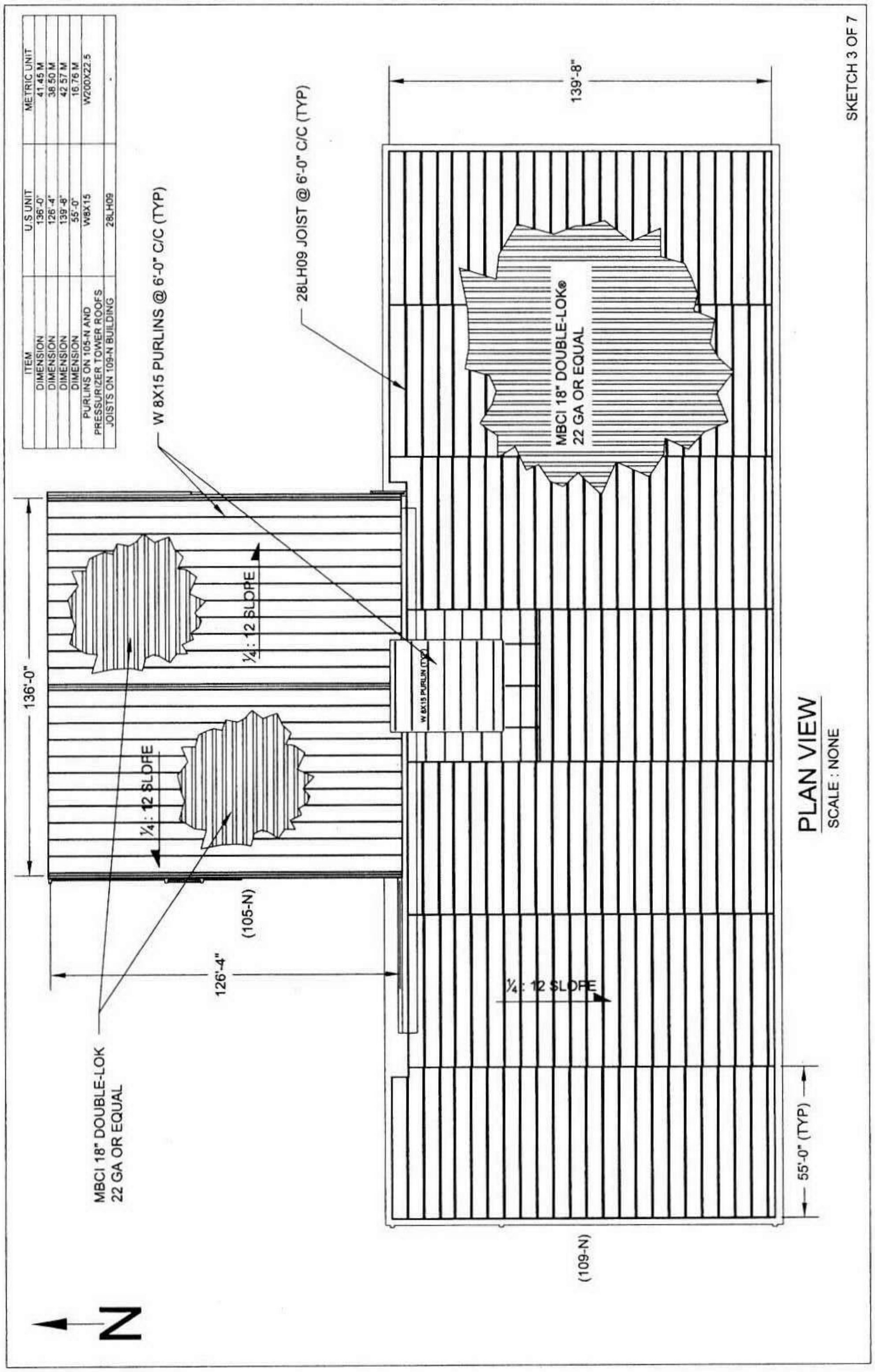
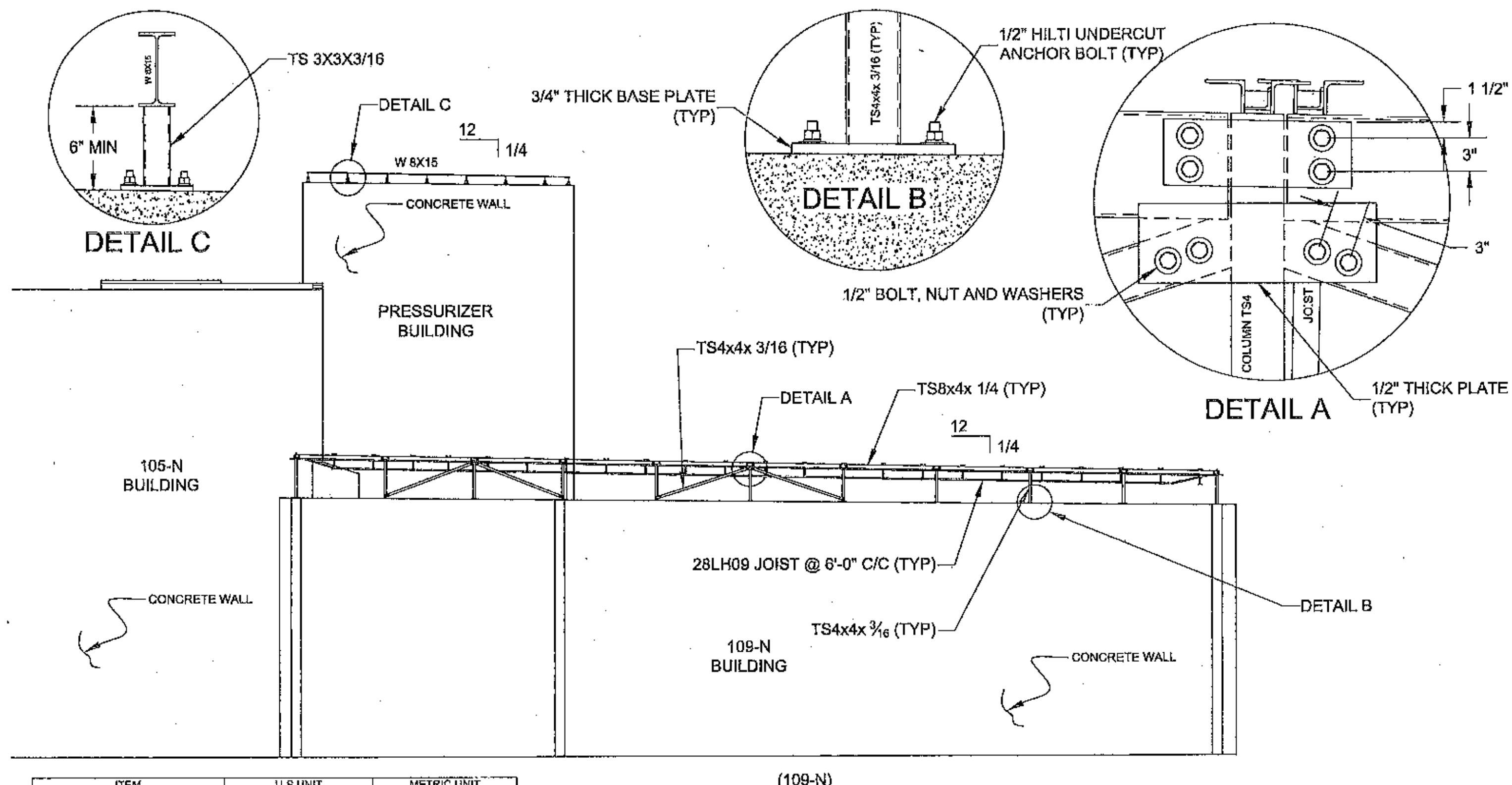

ITEM | U.S UNIT | METRIC UNIT
DIMENSION | 136'-0" | 41.45 M
DIMENSION | 126'-4" | 38.50 M
DIMENSION | 139'-8" | 42.57 M
DIMENSION | 55'-0" | 16.76 M
PURLINS ON 105-N AND PRESSURIZER TOWER ROOFS | W8X15 | W200X22.5
JOISTS ON 109-N BUILDING | 28LH09 | -
W 8X15 PURLINS @ 6'-0" C/C (TYP)
28LH09 JOIST @ 6'-0" C/C (TYP)
139'-8"
SKETCH 3 OF 7
MBCI 18" DOUBLE-LOK®
22 GA OR EQUAL
136'-0"
¼ : 12 SLOPE
¼ : 12 SLOPE
W 8X15 PURLIN (TYP)
PLAN VIEW
SCALE : NONE
(105-N)
126'-4"
¼ : 12 SLOPE
MBCI 18" DOUBLE-LOK
22 GA OR EQUAL
55'-0" (TYP)
(109-N)
N

Figure A-3.



ITEM	U.S UNIT	METRIC UNIT
DIMENSION	6'-0"	1.83 M
STUB COLUMNS ON 105N BLDG	TS3X3X 3/16	HSS76.2X76.2X4.8
COLUMNS AND BRACINGS ON 109-N	TS4X4X3/16	HSS101.6X101.6X6.4
SHORT BEAM ON 109-N	TS8X4X1/4	HSS203.2X101.6X6.4
LONG BEAM ON 109-N (TOTAL 5 REQUIRED)	TS20X4X1/4	HSS508X101.6X12.7
PURLINS ON 105-N AND PRESSURIZER TOWER ROOFS	W8X15	W200X22.5
JOISTS ON 109-N BUILDING	28K12	-
BOLTS ON GUSSETS	½" DIA	12 MM DIA
ANCHOR BOLTS	½" DIA	12 MM DIA

WEST SIDE ELEVATION

(SIDING NOT SHOWN)
SCALE : NONE
EAST SIDE ELEVATION OPPOSITE

SKETCH 6 OF 7

APPENDIX B

SSE CONCEPTUAL DESIGN CALCULATION

CALCULATION COVER SHEET (2)

Project Title River Corridor Closure Contract **Job No.** 14655

Area 100-N

Discipline Civil/Structural ***Calc. No.** 0100N-CA-C0054

Subject Conceptual Design of 105N/109N Interim Safe Storage Enclosure

Computer Program N/A **Program No.** N/A

The attached calculations have been generated for a specific purpose and task. Use of these calculations by persons who do not have access to all pertinent facts may lead to incorrect conclusions and/or results. Before applying these calculations to your work, the underlying basis, rationale, and other pertinent information relevant to these calculations must be thoroughly reviewed with appropriate Washington Closure Hanford LLC (WCH) officials or other authorized personnel. WCH is not responsible for the use of a calculation not under its direct control.

Committed Calculation ☐ **Preliminary** ☒ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
A	Total 32 sheets (Cover Sheet *plus* Sheets 1 through 31)	IKGhosh I.K. Ghosh	JNWinters J.N. Winters	N/A	RGEgge R.G. Egge	4-26-06

SUMMARY OF REVISION

WCH-DE-019 (04/14/2006) *Obtain Calc. No. from R&DC and Form from Intranet

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh	Date	4/20/06	Calc. No.	0100N-CA-C0054		Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked		J.N. Winters	Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure						Sheet No.	1 of 31

TABLE OF CONTENTS

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG		**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract		**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**						**Sheet No.**	2 of 31

References

1.0 Scope

Design of 105-N/109N/Pressurizer Tower roof interim safe storage (ISS) enclosure structure.

2.0 Material

105-N Building : Roofing material (existing) = 5½" (140 mm) of insulated concrete on metal deck

Dwg. H-I-27623

3.0 Loadings

3.1 Dead Load

(a) **105-N Building**

(b) For <u>existing</u> roof:

Assume Insulating concrete weight = 100 lb/ft^3 (1,602 kg/m^3).

- Dead weight of 5½" (140 mm) of insulated concrete (average depth = 4¾" (121 mm))

$$= 100 \text{ lb/ft}^3 \times 4.75''/12 = 39.58 \text{ lb/ft}^2 \ (1{,}895 \text{ N/m}^2)$$

- Dead weight of existing metal deck = 1.5 lb/ft^2 (72 N/m^2) (*Assumed*)

Therefore, total dead weight = 39.58 + 1.5

= **41.08** lb/ft^2 (1,967 N/m^2) for <u>existing</u> roof.

(c) **109-N/105-N Buildings**

Dead weight of <u>new</u> metal deck = 3 lb/ft^2 (143.6 N/m^2) *Assumed conservatively.*

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	3 of 31

3.2 Ash Fall Load

24 lb/ft^2 (1,149 N/m^2)

BHI-00747, Rev. 3, page 4-2

3.3 Snow load

20 lb/ft^2 (958 N/m^2)

BHI-00747, Rev. 3, page 4-2

3.4 Miscellaneous loads (such as equipment, piping, etc.)

None

3.5 Thermal Load

No thermal load analysis is required since all connections are bolted, and all members have enough flexibility to move rather freely under thermal condition.

3.6 Wind load

ASCE 7-02, Section 6.5.12.4.2

Wind speed = 85 mph (38 m/s)
Exposure Category C
Height of roof from grade = 70'-6" (21.5 m)
Since h > 60 ft (18.3 m), Section 6.5.12.4.2 of ASCE 7-02 applies.

BHI-00747, Rev. 3, page 4-1
Dwg. H-I-27625

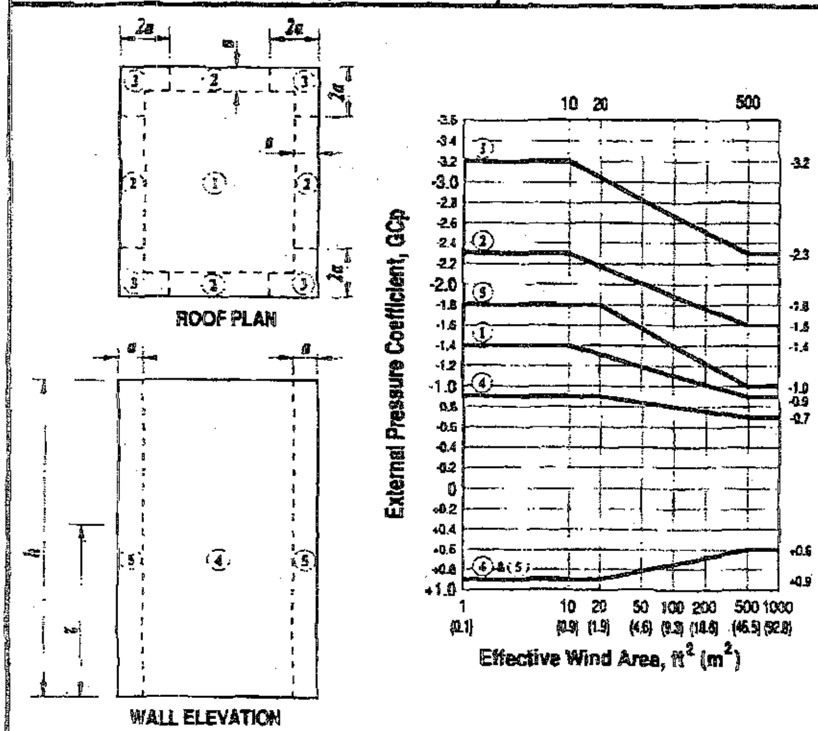
Washington Closure Hanford LLC

CALCULATION SHEET

Originator	I.K. Ghosh	Date	4/20/06	Calc. No.	0100N-CA-C0054		Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters		Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure						Sheet No.	4 of 31

SEI/ASCE 7-02, Page 67

Components and Cladding – Method 2		h > 60 ft.
Figure 6-17	External Pressure Coefficients, GC_p	Walls & Roofs
Enclosed, Partially Enclosed Buildings		



Notes:

1. Vertical scale denotes GC_p to be used with appropriate q_z or q_h.
2. Horizontal scale denotes effective wind area A, in square feet (square meters).
3. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
4. Use q_z with positive values of GC_p and q_h with negative values of GC_p.
5. Each component shall be designed for maximum positive and negative pressures.
6. Coefficients are for roofs with angle $\theta \le 10°$. For other roof angles and geometry, use GC_p values from Fig. 6-11 and attendant q_h based on exposure defined in 6.5.6.
7. If a parapet equal to or higher than 3 ft (0.9m) is provided around the perimeter of the roof with $\theta \le 10°$, Zone 3 shall be treated as Zone 2.
8. Notation:
   - a: 10 percent of least horizontal dimension, but not less than 3 ft (0.9 m).
   - h: Mean roof height, in feet (meters), except that eave height shall be used for $\theta \le 10°$.
   - z: height above ground, in feet (meters)
   - θ: Angle of plane of roof from horizontal, in degrees.

Wind Pressure, $p = q(GC_p) - q_i(GC_{pi})$ (lbf/ft^2) (N/m^2)

ASCE 7-02, Section 6.5.12.4.2 and Eq. 6-23

GC_p= External pressure coefficients
GCpi= Internal pressure coefficients
q= Velocity pressure (lbf/ft^2) (N/m^2)
q_i= Velocity pressure for internal pressure determination (lbf/ft^2) (N/m^2)

Consider wind effective area > 1,000 sq. ft. for both roof and wall.

ASCE 7-02, Figure 6-17

For Roof:

GC_p= -0.9 for the middle part of the roof (Area 1, See Fig. 6-17, see previous page)
= -1.6 for the roof corners (Area 2, See Fig. 6-17, see previous page)
= -2.3 for the wall (Area 3, See Fig. 6-17, see previous page)

For Wall:

GC_p = -0.7 for the middle part of the wall (Area 4, See Fig. 6-17, see previous page)
= +0.6 for the wall (Areas 4 and 5, See Fig. 6-17, see previous page)

GC_{pi} = +0.18 and -0.18

ASCE 7-02, Figure 6-5

$K_z = 1.17$ for h = 70' (21.3 m)

ASCE 7-02, Section 6.5.6.6 and Table 6-3

$K_d = 0.85$

ASCE 7-02, Section 6.5.4.4 and Table 6-4

$K_{zt} = (1 + K_1 K_2 K_3)^2$
$H/L_h = 0$; $x/L_h = 0$;
$K_2 = K_3 = 1.0$; $K_1 = 0$ [Note: There is no hill or escarpment]
Therefore, $K_{zt} = 1.0$

ASCE 7-02, Section 6.5.7.2, and Figure 6-4

I_w = Importance Factor = 1.15 (*Assume*)
[Note: I_w = 1.15 has been used for the design of D-Reactor enclose roof.]

ASCE 7-02, Table 6-1

$q_i = q_h = 0.00256\, K_z\, K_{zt}\, K_d\, V^2\, I_w$ lbf/ft², V in mph
($q_i = q_h = 0.613\, K_z\, K_{zt}\, K_d\, V^2\, I_w$ N/m², V in m/s)

ASCE 7-02, Section 6.5.10

Therefore, $q_i = 0.00256 \times 1.17 \times 1.0 \times 0.85 \times (85)^2 \times 1.15$ lbf/ft²
= 21.15 lbf/ft² (1,013 N/m²).

Hence wind pressure, $p = q(GC_p) - q_i(GC_{pi})$

- Roof wind design loads:

Area 3: $GC_p = -2.3$, $p = 21.15\ (-2.3 - 0.18) = -52.5$ lbf/ft^2 (-2,514 N/m^2)

Area 1: $GC_p = -0.9$, $p = 21.15\ (-0.9 - 0.18) = -23$ lbf/ft^2 (-1,101 N/m^2)

- Wall wind design loads:

Area 4: $GC_p = -0.7$, $p = 21.15\ (-0.7 - 0.18) = -18.6$ lbf/ft^2 (-891 N/m^2)

Area 5: $GC_p = +0.6$, $p = 21.15\ (0.6 - 0.18) = +9$ lbf/ft^2 (+431 N/m^2)

4.0 105-N Building

4.1 Roof Purlins (EL. 70'-6")

Max. Span, L = 16'-6" (5 m)
Max. Spacing of Purlins = 6' (1.83 m)

Try purlin size W8x15 (W200x22.5)

50 ksi (345 MPa) Steel; $I_{xx} = 48$ in^4 (2,000 cm^4); $S = 11.8$ in^3 (194 cm^3)
$d/A_f = 6.41$; E = 30,000 ksi (206,900 MPa)

- Design Load:

Dead weight of new metal deck (3 lbf/ft^2) + Ash load (24 lbf/ft^2)
= 27 lbf/ft^2 x 6' = 162 lbf/ft (2,364 N/m)

ASCE 7-02, Section 2.4

Dead weight of Purlin = 15 lbf/ft (219 N/m)

Total design load = 162 + 15 = 177 lbf/ft (2,582 N/m)

Maximum bending moment = 0.177 kips x $16.5^2/8$ = 6.0 k-ft (8.17 kN-m)

Allowable Bending Stress, $F_b = 0.6F_y = 0.6 \times 50 = 30$ ksi (207 MPa) — AISC, 9[th] Ed. ASD, Eq. F1-8
Actual bending stress, $f_b = 6.0 \times 12/11.8 = 6.1$ ksi (42 MPa)
<< 30 ksi (207 MPa) (OK)

- Check for Wind Uplift Load:

Maximum Uplift load = -52.5 lbf/ft^2 (-2,514 N/m^2)
Downward deck load = 3 lbf/ft^2 (144 N/m^2)
Net upward load/ft (for W8 purlin)= (-52.5 + 3) lbf/ft^2 x 6' + 15 lbf/ft
[Note 15 lbf/ft is the weight of purlin]
= -282 lbf/ft (-4,114 N/m)

Design bending moment = 0.282 kips x $16.5^2/8$ = 11.3 k-ft (15.3 kN-m)

Allowable Bending Stress, $F_b = 1.33 \times 12{,}000/(Ld/A_f)$ — AISC, 9th Ed. ASD, Eq. F1-8
= 1.33 x12,000/(16.5 x 12 x 6.41)
= 12.63 ksi (86.5 MPa)

Actual bending stress, f_b = 9.6 x 12/11.8 = 9.8 ksi < 12.63 ksi (86.5 MPa) (OK)

- Deflection of W8 Check (due to uplift): — AISC, 9th Ed. ASD, Page 2-296
  w = 282/12 = 23.5 lbf/in (4,114 N/m)

  Use formula $\delta_{max} = 5wL^4/384EI$
  $= 5 \times (23.5/1000) \times (16.5\times12)^4/(384 \times 30{,}000 \times 48)$
  = 0.33 in (8.4 mm) < L/240 = 16.5x12/240 = 0.83 in (21 mm) OK

Therefore,
<u>USE W8x15 (W200x22.5) for all purlins on 105-N Building Roof at a maximum spacing of 6' (1.83 m).</u>

Dwg H-I-27793

4.2 Check <u>Existing</u> Roof Beams

Consider beam WF10x21 (Located between 15.6-16.7 and G.s - G.g, See archived drawing H-I-27793): A = 6.19 in^2; I_x = 106.3 in^4; S_x = 21.5 in^3. — AISC Shapes Database

Span of WF10 beam = 22'-5" = 22.417 ft ; Max spacing = 16'-5" /2 = 8.2 ft

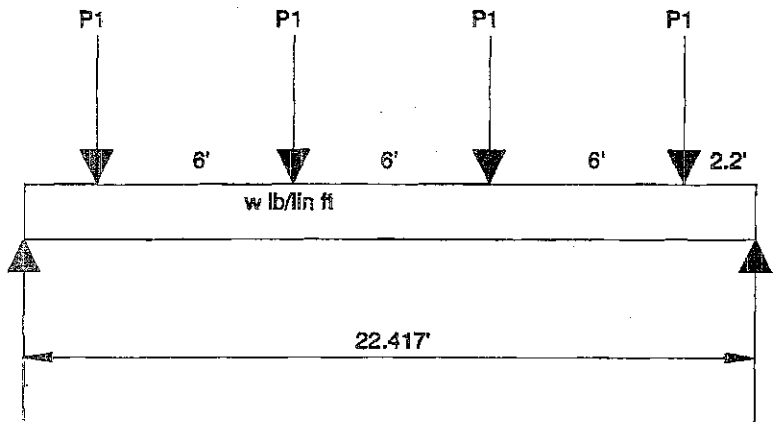
Assume this beam carrying 4 purlins, one in the center, and the other two 6' (1.83 m) from center. Thus 4 point loads on the beam.

Assume Yield Stress, F_y = 36 ksi (248 MPa)

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters *JNW*	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	8 of 31

Loads on WF10:



Dead weight of existing concrete and decking
w = 41.08 lb/ft^2 x 8.2' max. spacing = 0.337 k/lin. ft (4.9 kN/m)

Section 3.1 (a) of this package.

Dead weight of new decking + Ash Load + Weight of Purlin (W8x15)
P1 = (3 + 24)lb/ft^2 x 8.2' x 6' + 15 lb/ft x 8.2' = 1.45 k (6.4 kN)

Section 3.2 of this package.

Maximum bending moment = $0.337 \times 22.417^2/8 + 1.45(2 \times 11.2 - 3 - 9)$
= 36.28 k-ft (49.2 kN-m)

Bending stress, f_b = 36.28 x12/21.5 = 20.2 ksi < 0.6x36 = 21.6 ksi (149 MPa) (OK)

Comment: Actually the purlin and existing beam will act together, and the bending stress in existing beam will be much less than 20.2 ksi (145 MPa).

CONCLUSION: **Existing beams are adequate to support the new purlins.**

Washington Closure Hanford LLC

CALCULATION SHEET

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	9 of 31

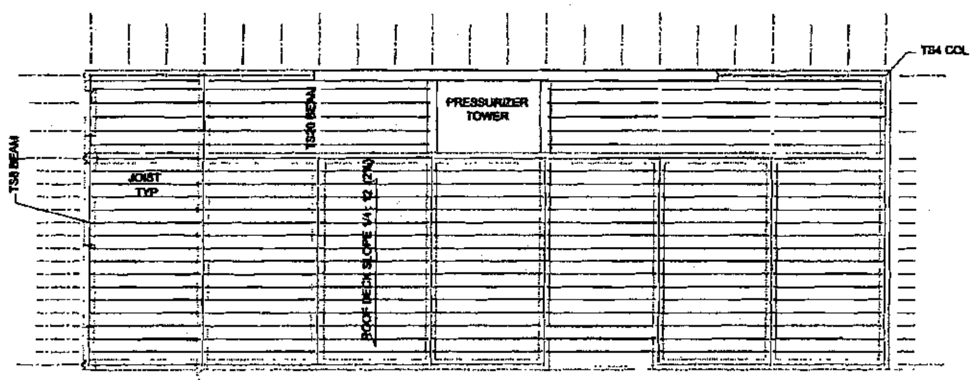
4.3 Design of Pressurizer Tower Roof Steel (EL. 87'-3")

Use same purlins as Section 4.1: W8x15 (W200x22.5) @ 6' (1.83 m) spacing.

4.4 Design of Deck (105-N and Pressurizer Tower)

See Section 5.2

5.0 109-N Building



NOTE:
ALL COLUMNS; TS4X4X 3/16
ALL SHORT BEAMS: TS8X4X 1/4
ALL LONG BEAMS: TS20X4X3/8
ALL JOISTS: 28K12

109-N BUILDING
ISS ENCLOSURE STEEL LAYOUT PLAN

5.1 Design of Joists

Maximum Joist Span, L = 55 ft (16.8 m)
Maximum spacing = 6' (1.83 m)

Design Loads:

Weight of Joist (Assume SJI 28LH09) = 21 lbf/ft (306 N/m)
Deck Weight = 3 lb/ft^2 x 6 ft spacing = 18 lbf/ft (263 N/m)
Total Dead Load = 18 + 21 = 39 lb/ft (569 N/m)

See Attachment 1 for Joist dead weight

Washington Closure Hanford LLC		CALCULATION SHEET					
Originator	I.K. Ghosh IKG	Date	4/20/06	Calc. No.	0100N-CA-C0054	Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters JNW	Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					Sheet No.	10 of 31

Live Load: Ash Load 24 lb/ft^2 x 6 ft= 144 lbf/ft (2,101 N/m)

Total Dead + Live Loads = 39 + 144 = 183 lbf/ft (2,670 N/m)

Try 28LH09 (LH-Series, Steel Joist Institute Standard)
Allowable total load = 387 lbf/ft (5,646 N/m) > 183 lbf/ft (2,670 N/m) (OK)

Allowable live load (for max deflection L/360) = 183 lb/ft (2,670 N/m) > 144 lbf/ft (2,101 N/m) (OK).

See Attachment 1 for allowable joist load

Therefore, 28LH09 is adequate.

USE **<u>28LH09 joists @ max spacing of 6' (1.83 m)</u>**.

NOTE: UNDER NO CIRCUMSTANCES SHALL ANY PERSONNEL ATTEMPT TO WALK ON UNBRIDGED JOISTS. AS SOON AS THE JOISTS ARE ERECTED, ALL BRIDGING SHALL BE COMPLETELY INSTALLED AND ANCHORED, THE JOISTS BE PERMANENTLY FASTENED INTO PLACE. **UNTIL THIS IS DONE, NO CONSTRUCTION LOAD SHALL BE APPILED TO THE JOISTS.**

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters *JNW*	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	11 of 31

5.2 Design of Deck

Single span = 6 ft max. (1.83 m)
[Try MBCI 18" or 24" Double-Lok®, 22 ga]
Dead load (DL) = 1.65 lb/ft^2 (143.6 N/m^2)
Live Load (LL) (Ash Load) = 24 lb/ft^2 (1,149 N/m^2)
Live Load (LL) (Wind Load) = -24 lb/ft^2 (-1,149 N/m^2)

For Double-Lok® data, see Appendix B of this Calc.

Total DL + LL (ash Load) = 1.65 + 24 = 26 lbf/ft^2 (1,245 N/m^2).

Wind Load: For **Area 3** uplift load is = 52.5 lbf/ft^2 (2,514 N/m^2)
[Note: Area 3 is only at the corners]

See Section 3.5

Wind Load: For **Area 1** uplift load is = 23 lbf/ft^2 (1,101 N/m^2)
[Note: Area 1 is the majority of the roof]

Total DL + LL (Wind Load) = 1.65 – 52.5 = -51 lbf/ft^2 (2,442 N/m^2) [Area 3]
= 1.65 – 23 = -21.4 lbf/ft^2 (1,022 N/m^2) [Area 1]

MBCI 24" Double-Lok®, 22 ga :

Uplift Load: Allowable wind load = 47.2 lbf/ft^2 (2,260 N/m^2)
This is slightly less than 51 lbf/ft^2 (2,442 N/m^2)
[Acceptable, since Area 3 does not control.
Also note that for wind the allowable stress can be increased by 33%.]

See Attachment 2 for allowable loads on roof deck (see page 30 of this calc).

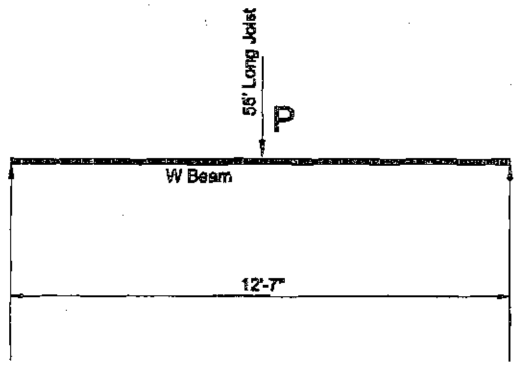
Downward Load:
Total DL + LL (ash Load) = 1.65 + 24 = 26 lbf/ft^2 (1,245 N/m^2).
Allowable load = 92 x $(5.5/6)^2$ = 77.3 lbf/ft^2 (3,700 N/m^2)
>> 26 lbf/ft^2 (1,245 N/m^2) [OK]

See Attachment 2 for allowable loads on roof deck (see page 31 of this calc).

Therefore, **USE MBCI 24" Double-Lok®, 22 ga or equivalent @ maximum span of 6 ft (1.83 m). Use decks at least in double span.**

5.3 Design of Short Beams, Max Span 12'-7" (3.84 m), on 109-N Building

Beam Span = 12'-7" = 12.583 ft (3.84 m)



Try Beam W8x15 (W200x22.5)

50 ksi (345 MPa) Steel; I_{xx} = 48 in^4 (2,000 cm^4); S = 11.8 in^3 (194 cm^3)
E = 30,000 ksi (206,900 MPa)

P = Load from joist = 183 lb/ft x 55/2' = 5.03 kips (22.4 kN) — See Section 5.1
Maximum bending moment = 5.03 x 12.583/4 + 0.015 x 12.583^2/8
= 16.1 k-ft (22.0 kN-m)

$F_b = 0.6F_y$ = 0.6 x 50 = 30 ksi (207 MPa) — AISC, 9th Ed. ASD, Eq. F1-8
f_b = 16.1 x 12/11.8 = 16.4 ksi < 50 ksi (345 MPa) (OK)

Deflection at the middle of beam = PL^3/48EI = 5.03 x 151^3/ (48 x 30,000 x 48) = 0.25" (6.4 mm) < L/240 (OK) — AISC, 9th Ed. ASD, Page 2-298

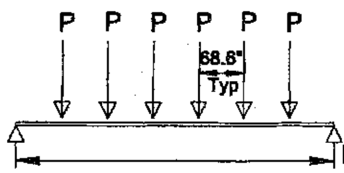
Therefore,

USE **<u>W8x15 (W200x22.5) or TS8x4 x 1/4 (HSS203.2x101.6x6.4) for all short beams.</u>**

Washington Closure Hanford LLC — **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters *JNW*	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	13 of 31

5.4 Design of Long Beams, 40' (12.2 m) Span on Gallery



P = 5.03 kips   Assume Beam self weight = 80 lb/ft (119 kg/m)
Maximum Bending Moment
$= 15.1 \times 20 - 5.03 \times (68.6/12)(0.5 + 1.5 + 2.5) + 0.08 \times 20^2/8$
$= 176.6$ k-ft (240 kN-m)

See Section 5.3

Try TS20x4x 1/2 (HSS508x101.6x12.7)
$F_y = 46$ ksi (317 MPa)
$I_{xx} = 889$ in^4 (37,002 cm^4)
$S_{xx} = 88.9$ in^3 (1,457 cm^3)

Allowable stress, $F_b = 0.6\,F_y = 0.6 \times 46 = 27.6$ ksi (190 MPa)
[Actually it is a compact section. So $F_b = 0.66F_y = 30.3$ ksi, but assumed $F_b = 0.6\,F_y = 27.6$ ksi conservatively.]

AISC, 9th Ed. ASD, Section F3, Page 5-48

Actual stress $f_b = 176.6 \times 12/88.9 = 23.8$ ksi < 27.6 ksi, OK

- **Check Deflection:**

Use formula $\delta_{max} = Pa(3L^2 - 4a^2)/(24EI)$, and $PL^3/48EI$

AISC, 9th Ed. ASD, Page 2-298

$\delta_1 = 5.03 \times 68.6(3 \times 480^2 - 4 \times 68.6^2)/(24EI) = 1{,}921{,}875/EI$
$\delta_2 = 5.03 \times 137.2(3 \times 480^2 - 4 \times 137.2^2)/(24EI) = 17{,}710{,}235/EI$
$\delta_3 = 5.03 \times 205.8(3 \times 480^2 - 4 \times 205.8^2)/(24EI) = 22{,}505{,}780/EI$

E = 30,000 ksi (206,900 MPa)
$\delta = \delta_1 + \delta_2 + \delta_3 = 42{,}137{,}890/EI = 1.58"$ (40.1 mm) < L/240 (OK)

Therefore,
USE <u>**TS20x4x 1/2 (HSS 508 x 101.6 x 12.7) with max span = 40 ft (12.2 m).**</u>

5.5 Design of Columns

Commanding area = 20'x 16.66' + 18.875 x 27.5 = 852 ft^2 (74.8 m^2)
Maximum load = Deck Load + Ash Load = 30 lbf/ft^2 (1,436 N/m^2)
Maximum load on a column = 852 x 30 = 25.6 kips (114 kN)

Max. Height = 10' (3.05 m) conservatively.

Try TS4x4x3/16 (HSS101.6 x 101.6 x 4.8) — AISC, 9th Ed.
Allowable load for 10' high column = 51 kips (227 kN) >> 25.6 kips (114 kN) OK — ASD, Page 3-43

Therefore, Use **<u>TS4x4x 3/16 (HSS 101.6 x 101.6 x 4.8) for all columns.</u>**

5.6 Design of Girts for 109-N Building

Maximum spacing of girts = 6 ft (1.83 m)
Maximum girt span, L = 14 ft (4.27 m)
Wall wind pressures = -18.6 lbf/ft^2 (-891 N/m^2)
Or, +9 lbf/ft^2 (+431 N/m^2)
Use -18.6 lbf/ft^2 (-891 N/m^2) for design.

Try C8x11.5 (C200x17.1) ASTM A529, Grade 50
F_y = 50 ksi (345 MPa)
I_{xx} = 32.6 in^4 (1,357 cm^4) ; S_{xx} = 8.14 in^3 (133 cm^3); d/A_f = 9.08
E = 30,000 ksi (206,900 MPa)
Allowable stress, $F_b = 1.33 \times 12{,}000/(L\ d/A_f)$ — AISC, 9th Ed.
$= 1.33 \times 12{,}000/(14 \times 12 \times 9.08)$ — ASD, Eq. F1-8
$= 10.5$ ksi (72 MPa)

Max. bending moment = $18.6 \times 6 \times 14^2/8$ = 2.7 k-ft (3.71 kN-m)

Actual bending stress = 2.7 x 12/8.14 = 4.0 ksi (27.4 MPa) < 10.5 ksi (72 MPa) OK

Therefore,
USE **<u>C8x11.5 (C200x17.1) ASTM A529, Grade 50 for all girts @ a maximum spacing of 6' (1.83 m).</u>**

5.7 Design of Bracings

Use <u>TS4x4x 3/16 (HSS 101.6 x 101.6 x 4.8) for all bracings.</u>

6.0 Conclusions

(a)	Use TS4x4x 3/16 (HSS101.6x101.6x4.8) for all columns in 109-N building.	See Section 5.5
(b)	Use TS8x4x 1/4 (HSS203.2x101.6x6.4) for all short beams (maximum span 12'-7" (3.84 m)) in 109-N building.	See Section 5.3
(c)	Use TS20x4x 1/2 (HSS 508x101.6x12.7) for all long beams in 109-N building gallery.	See Section 5.4
(d)	Use 28LH09 (Steel Joist Institute) for all open web joists in 109-N building. **NOTE:** UNDER NO CIRCUMSTANCES SHALL ANY PERSONNEL ATTEMPT TO WALK ON UNBRIDGED JOISTS. AS SOON AS THE JOISTS ARE ERECTED, ALL BRIDGING SHALL BE COMPLETELY INSTALLED AND ANCHORED, THE JOISTS BE PERMANENTLY FASTENED INTO PLACE. **UNTIL THIS IS DONE, NO CONSTRUCTION LOAD SHALL BE APPILED TO THE JOISTS.**	See Section 5.1
(e)	Use roof deck and siding (105-N, 109-N, and Pressurizer Tower): MBCI 24" Double-Lok® 22 gage or equivalent at a maximum span of 6 ft (1.83 m). Use roof decks at least in **<u>double span</u>**. Standing seam of roof system must be used.	See Section 5.2
(f)	Use roof slope ¼V:12H (2% slope) for all roofs (105-N, 109-N and Pressurizer Tower).	IBC 2003, Section 1507.4.2 (standing seam of roof system)
(g)	Use purlins for 105-N building and Pressurizer Tower Roof: W8x15 (W200x22.5) @ max spacing 6 ft (1.83 m), and maximum span = 16'-6" (5 m).	See Section 4.0

No purlins are required in 109-N building – open web joists act as purlins.

(h) How to place purlins on 105-N and Pressurizer Tower Roofs? — See Section 4.0

(i) Strip the foam cover on the roofs completely. Foam is a fire-hazard.
(ii) Cut out the roof locally (about 12" x12" (300 mm x 300 mm) area) over existing beams, and weld a TS3x3x3/16 (HSS 76.2x76.2x4.8) stub 6" (150 mm) high.
(iii) Anchor W8x15 (W200x22.5) purlins on these stubs.
(iv) Purlin span = 16'-6" (5 m) maximum.
(v) Purlin spacing = 6' (1.83 m) maximum.

(i) 109-N Roof Preparation: Strip the foam cover on the roof completely. Foam is a fire-hazard.

(j) Use girts C8x11.5 (C200X17.1) @ max. spacing 6' (1.83 m) for 109-N building. Girt span = 14 ft (4.27 m) maximum. — See Section 5.6

(k) Use TS4x4x3/16 (HSS 101.6x101.6x4.8) for all diagonal vertical bracings on 109-N. — See Section 5.7

(l) In the final design the following must be addressed:
(i) Bridging between the joists, and
(ii) Diagonal tension rods at the roof for the roof to act as a diaphragm.

7.0 References

a) *Minimum Design loads for Buildings and Other Structures*, SEI/ASCE 7-02.
b) *Manual of Steel Construction, Allowable Stress Design*, American Institute of Steel Construction (AISC), 9th Edition.
c) *General Design Criteria for Richland Environmental Restoration Project*, BHI-00747, Rev. 3.
d) Archived Drawings: H-I-27615, Rev. 7; H-I-27622, Rev. 5; H-I-27623, Rev.1; H-I-27625, Rev. 3; H-I-276127, Rev. 5; H-I-27646, Rev. 3; H-I-27793, Rev. 3; H-I-30706, Rev. 8; H-I-30748, Rev. 8; H-I-30749, Rev. 6; H-I-30759, Rev. 5; H-I-30771, Rev. 7; and H-I-30772, Rev. 6.
e) *AISC Shapes Database*, U.S. Customary & Metric Units, Versions 3.1 and 3.1H, 2003.
f) *Steel Joist Institute Catalog,* Myrtle Beach, SC 29577-6760, www.steeljoist.org.
g) MBCI Metal Roof and Wall Systems Catalog (www.mbci.com)

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	Date	4/20/06	Calc. No.	0100N-CA-C0054		Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters JNW		Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure						Sheet No.	17 of 31

8.0 Estimated Bill of Materials

Beam/ Column/ Plate	Total Weight (ton)	Total Weight (tonne)
Joist 28LH09	102	92
Purlins W8x15	24	22
Girts C8x11.5	2	2
Columns TS 3x3x3/16	0.5	0.5
Columns and Bracings TS 4x4x3/16	6	5
TS 8x4x1/4	8	7
TS 20x4x1/2	8	7
Base Plate 12x12x3/4	3	2
Connection Plate ¼" Thick	0.5	0.5
Total	**154**	**138**

Hilti Bolts ½" dia	**700 ea**

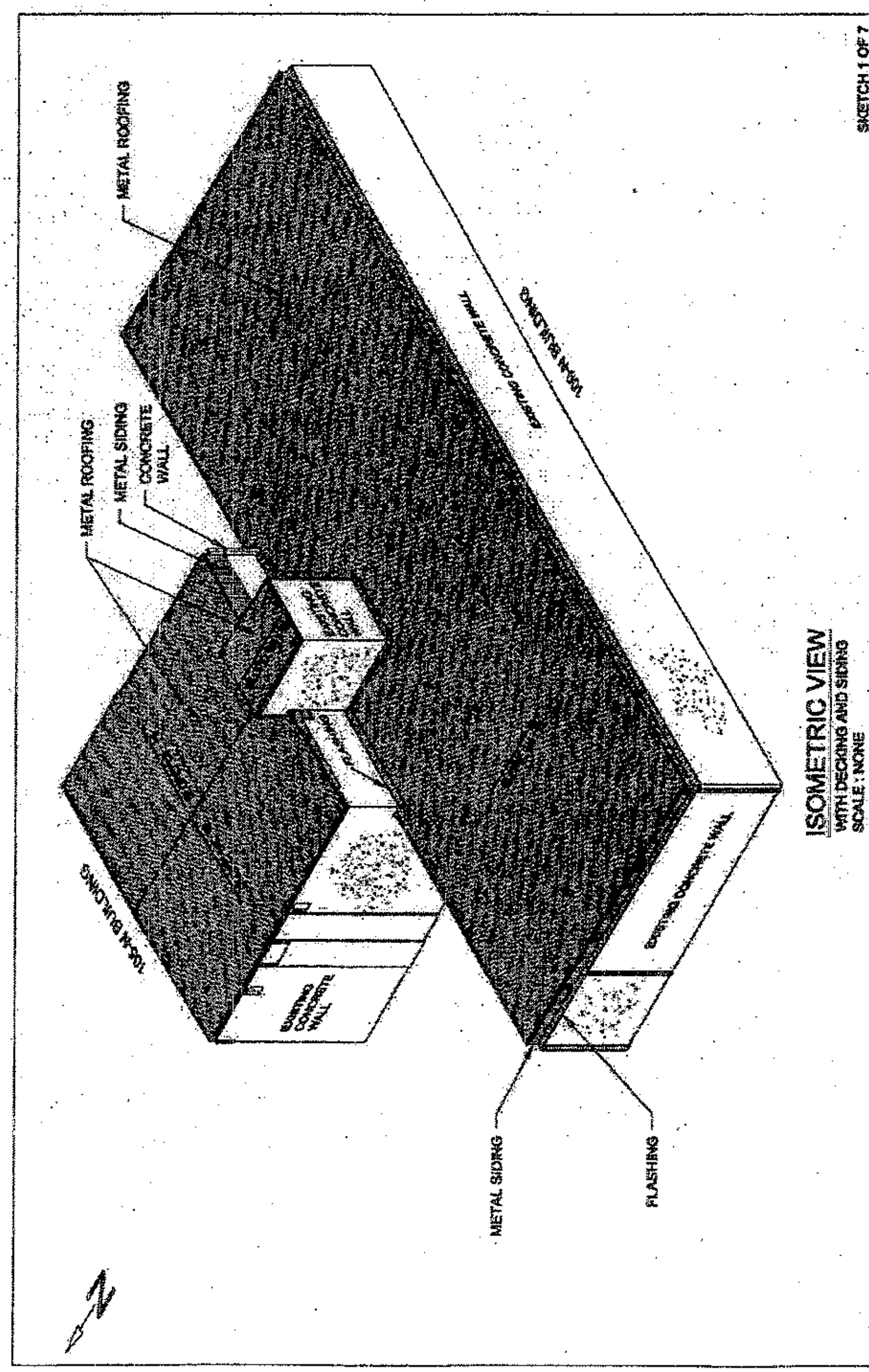
Roofing/ Siding	Total area (sq ft)	Total area (sq m)	Total Weight (ton)	Total Weight (tonne)
Roofing	71,000	6,600	60	55
Siding	6,800	632	6	6
Total	**77,800**	**7,232**	**66**	**61**

9.0 Structural Drawings and Details

Sketch 1 of 7 : Isometric View with Decking and Siding
Sketch 2 of 7 : Isometric View without Decking and Siding
Sketch 3 of 7 : Plan View
Sketch 4 of 7 : Partial Plan View (105-N Building)
Sketch 5 of 7 : Partial Plan View (109-N Building)
Sketch 6 of 7 : West Side Elevation (Siding not shown)
Sketch 7 of 7 : North and South Side Elevations

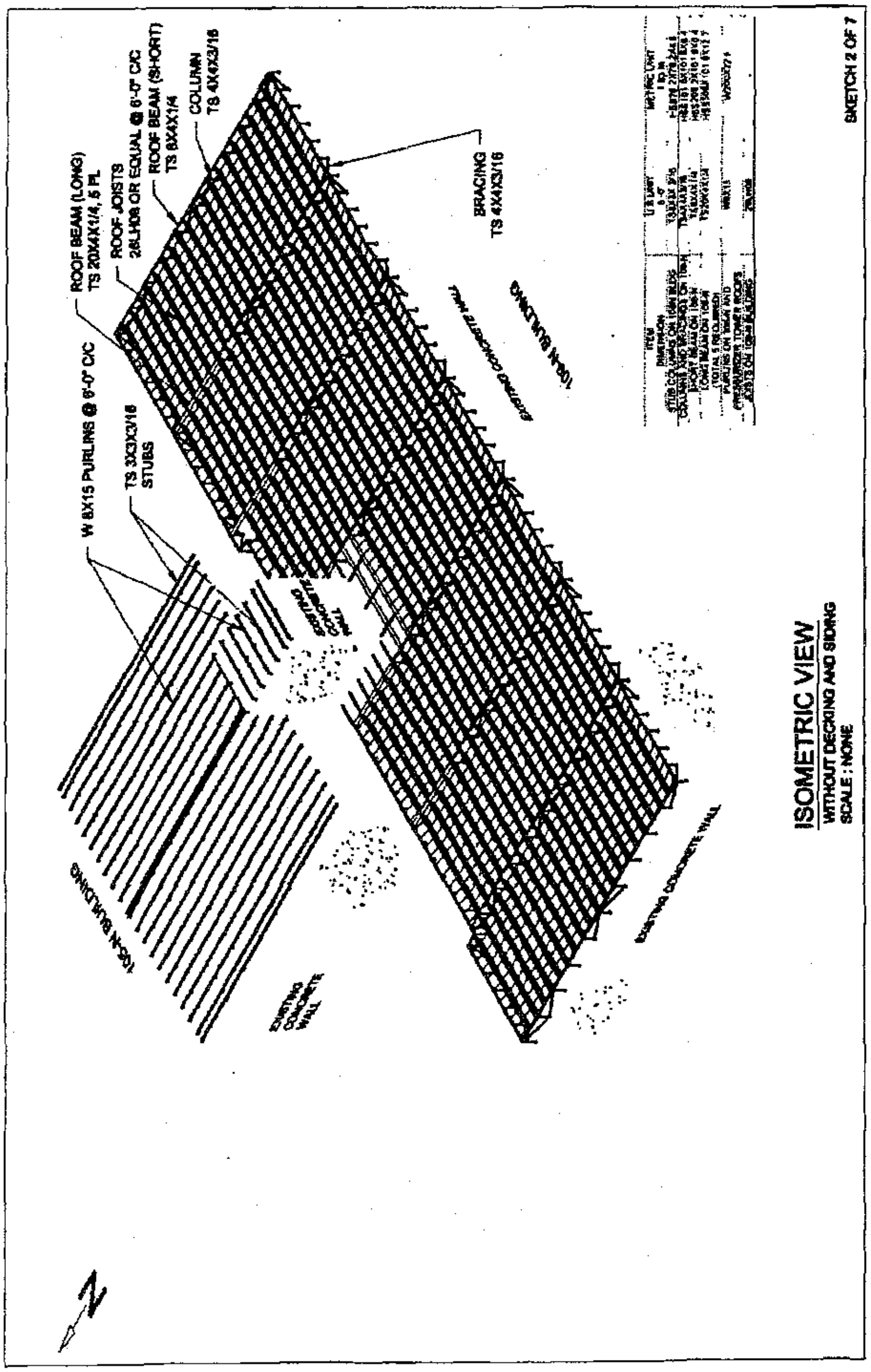
Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	18 of 31



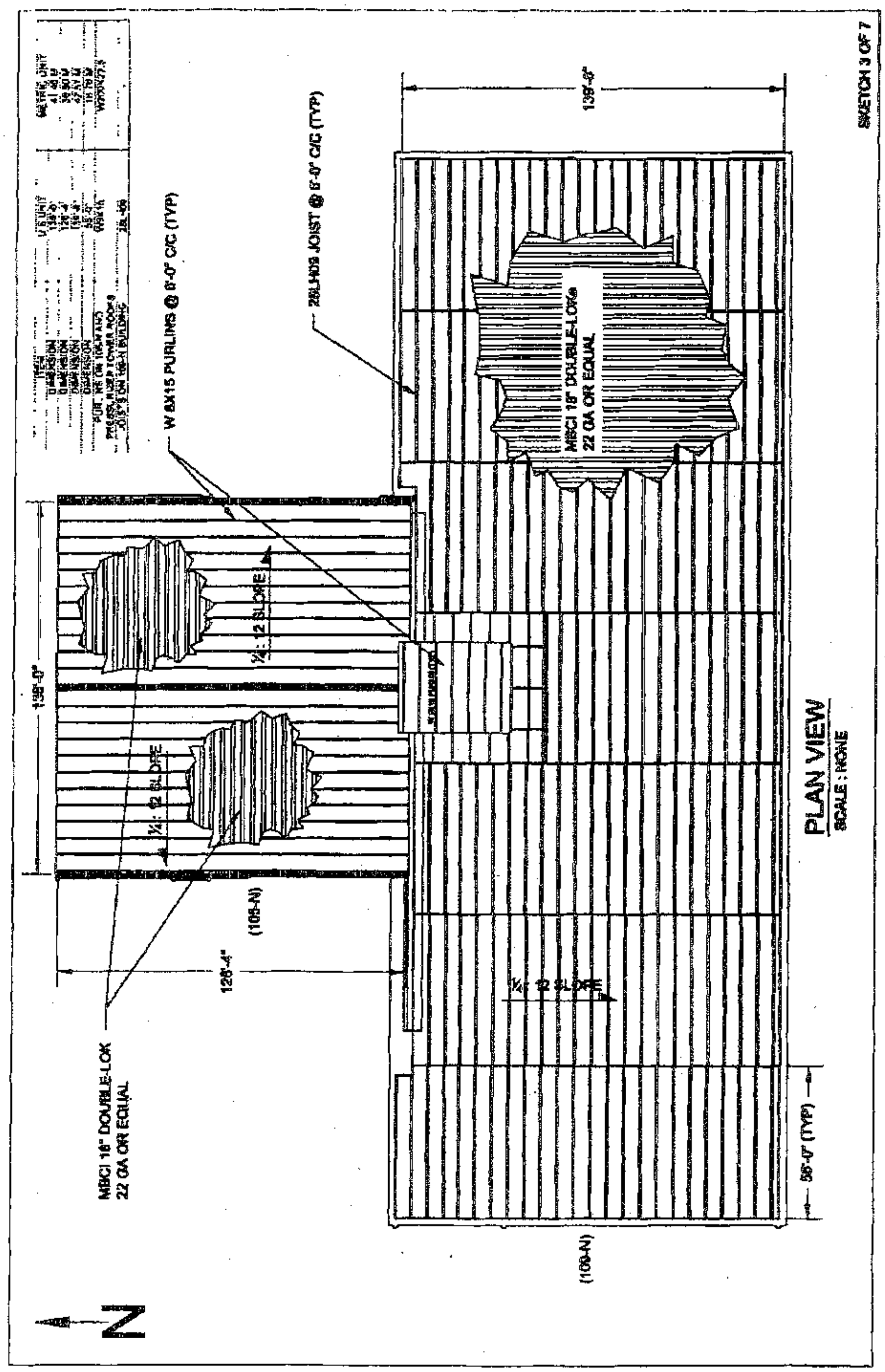
Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054			**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters			**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure							**Sheet No.**	19 of 31



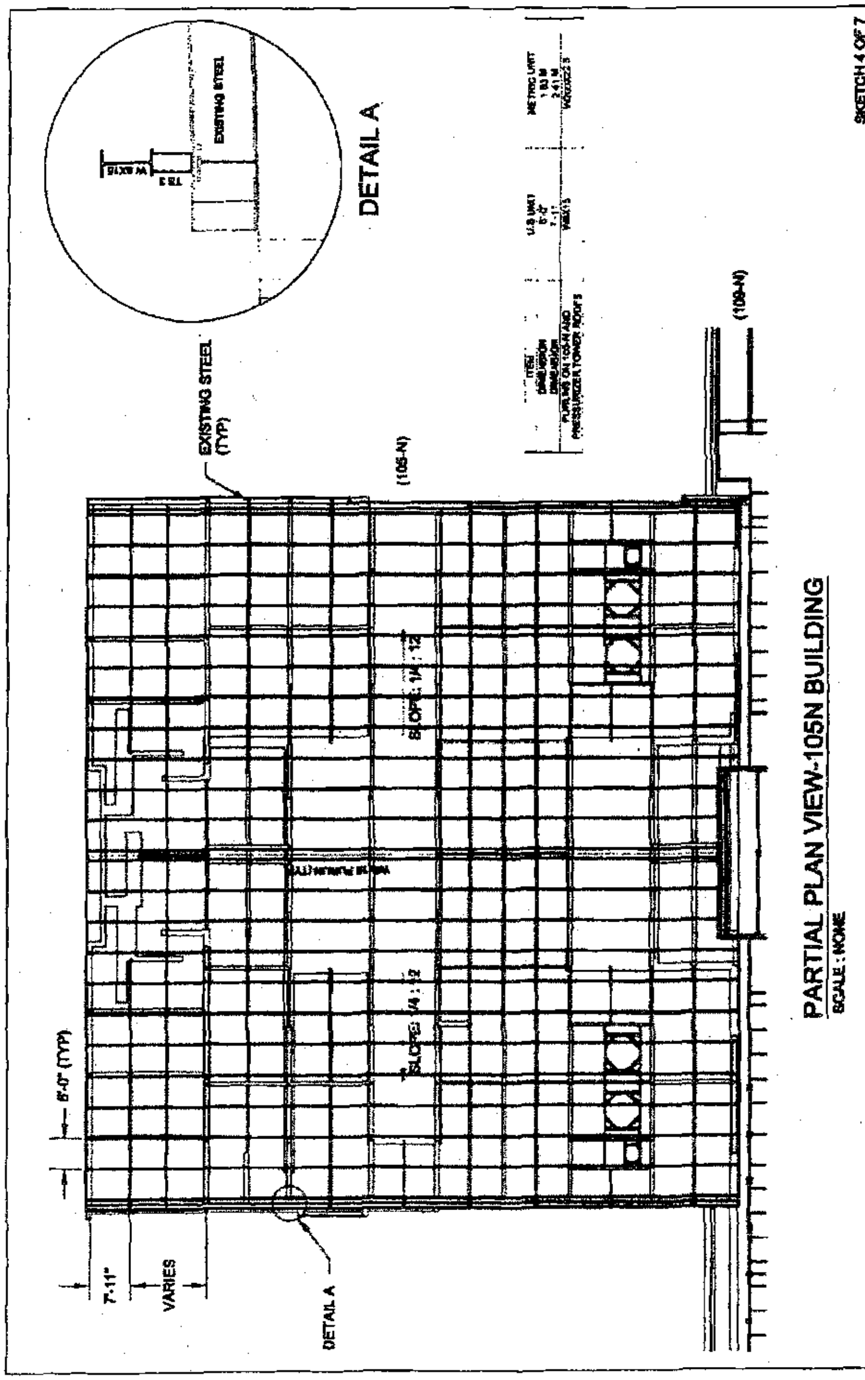
Washington Closure Hanford LLC — **CALCULATION SHEET**

Originator	I.K. Ghosh	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	20 of 31



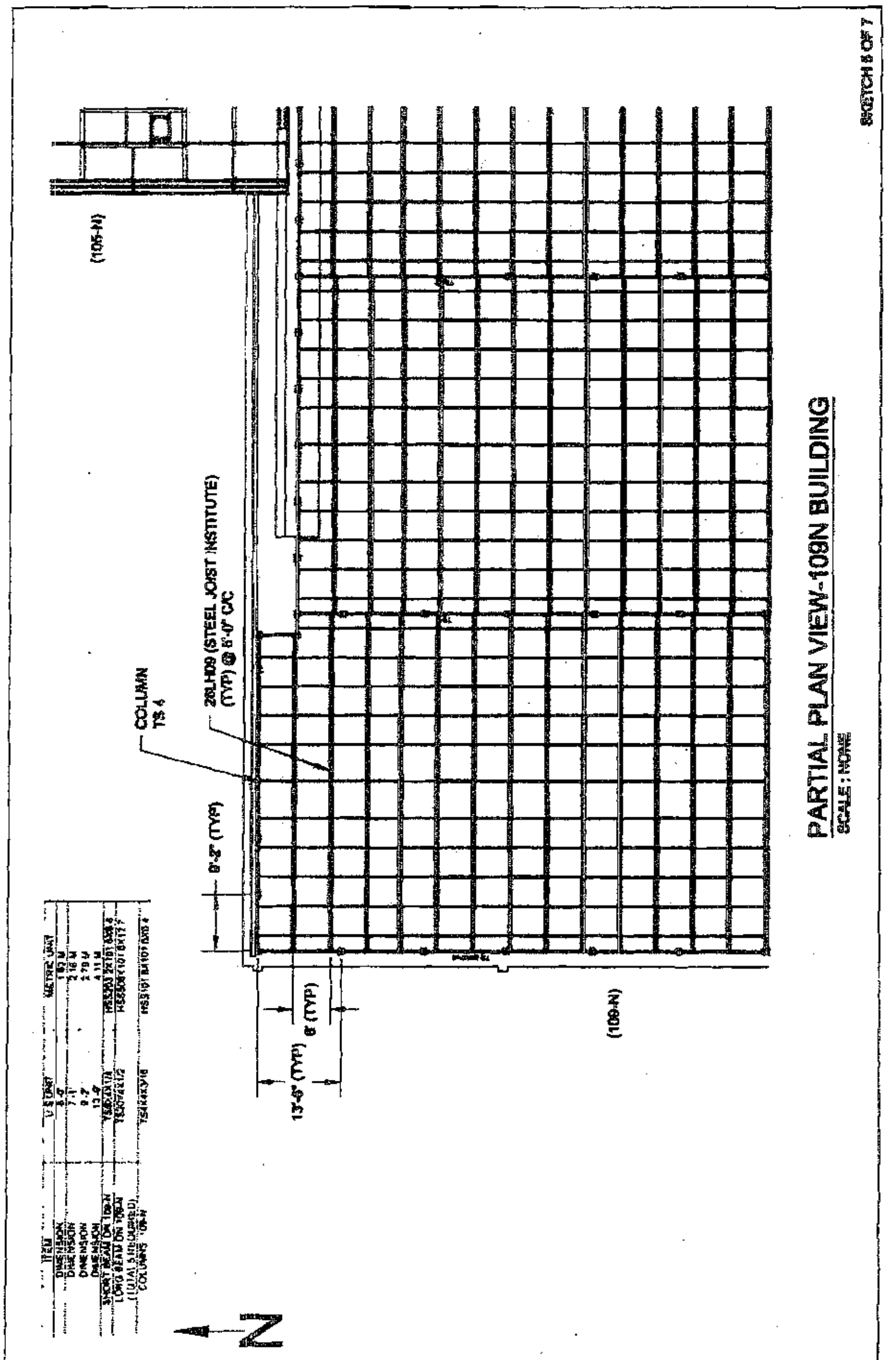
Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	21 of 31



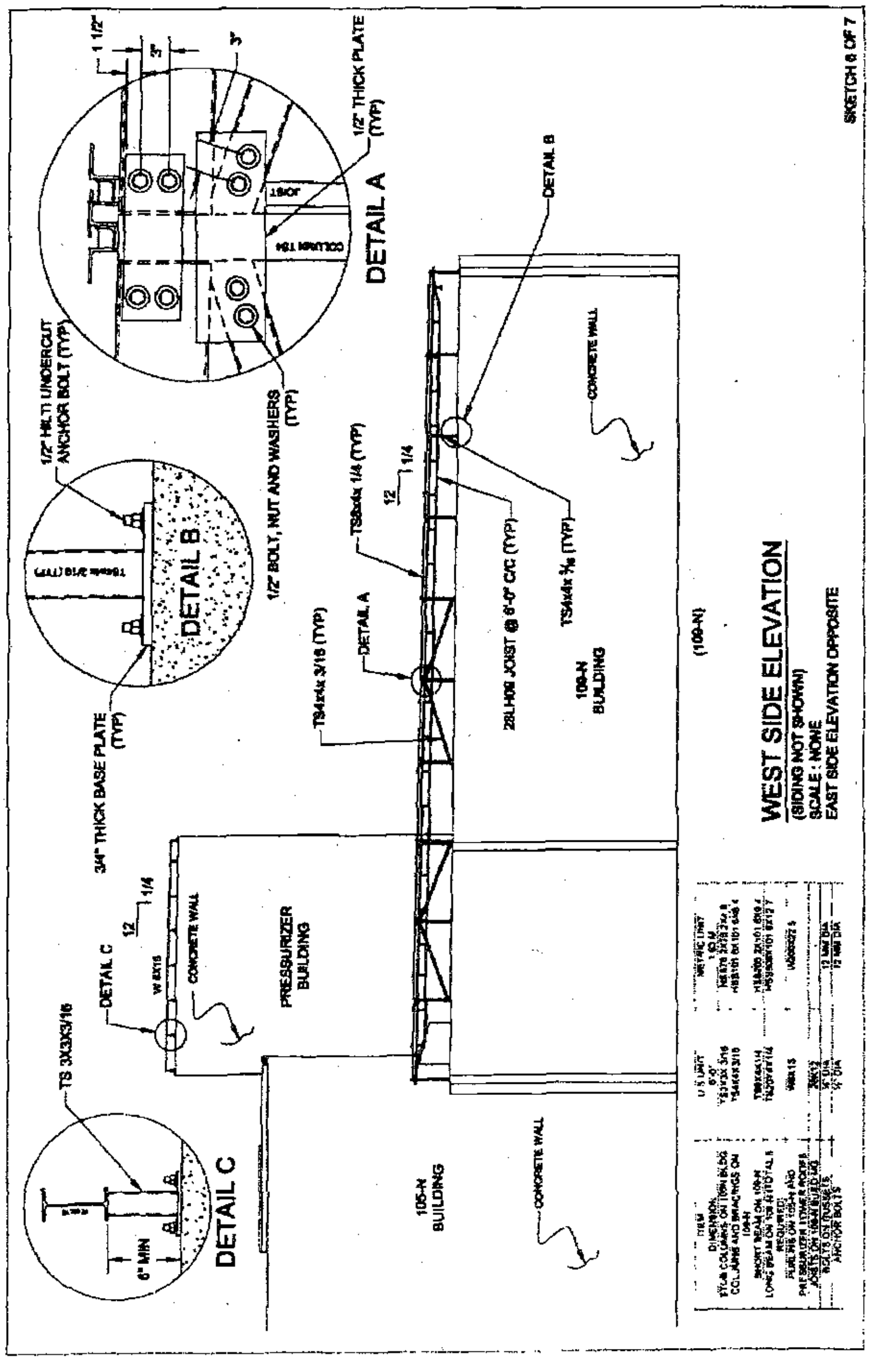
Washington Closure Hanford LLC — **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	22 of 31



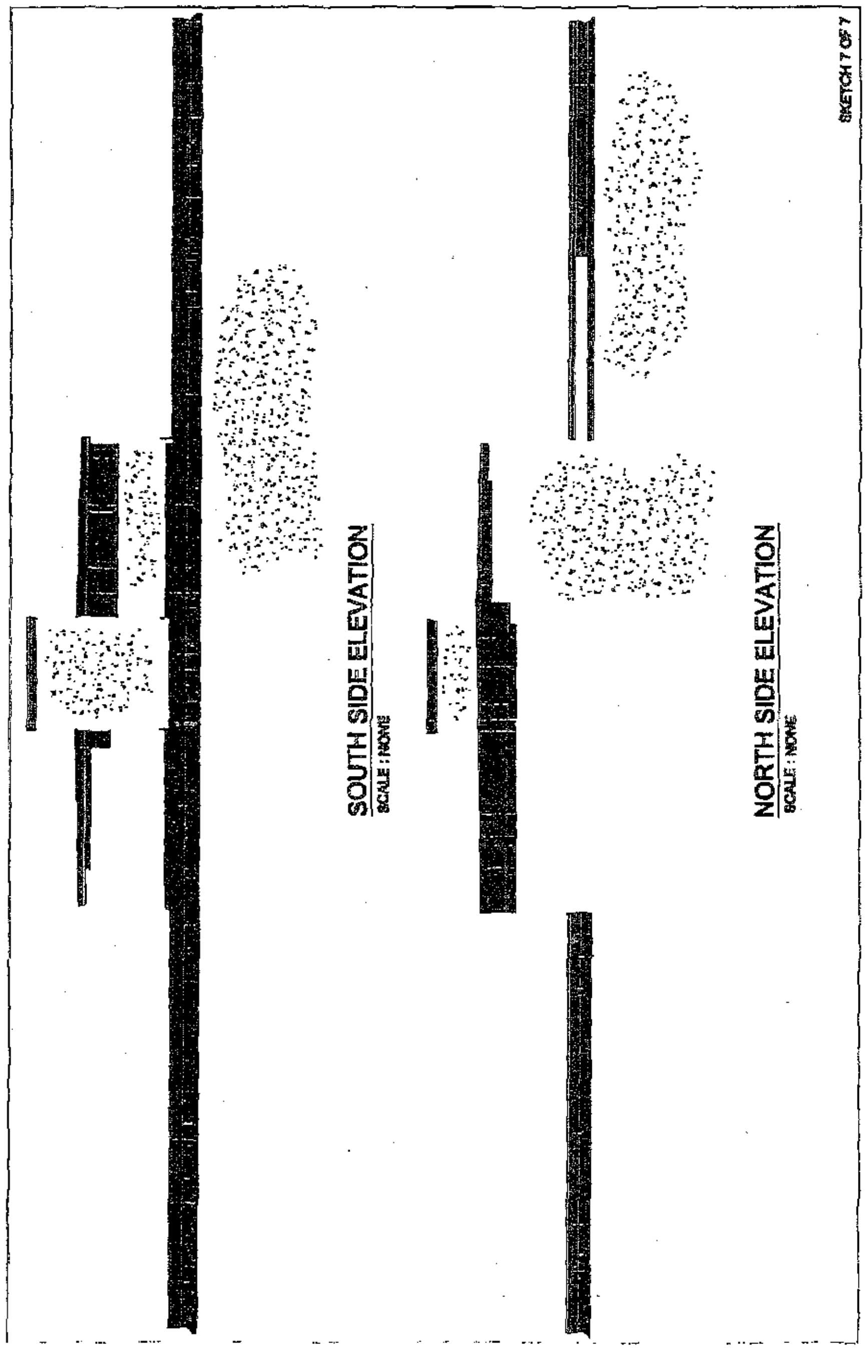
Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054		**Rev.**	A	
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters *JNW*		**Date**	4-20-06	
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure						**Sheet No.**	23 of 31	



Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters *JNW*	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	24 of 31



Washington Closure Hanford LLC		CALCULATION SHEET					
Originator	I.K. Ghosh	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	25 of 31

Attachment 1: Steel Joist Institute (SJI) Load Table

The RED figures in this load table are the LIVE loads per linear foot of joist which will produce an approximate deflection of 1/360 of the span. LIVE loads which will produce a deflection of 1/240 of the span may be obtained by multiplying the RED figures by 1.5. In no case shall the TOTAL load capacity of the joists be exceeded.

The approximate moment of inertia of the joist, in inches^4 is; $I_j = 26.767(W_{LL})(L^3)(10^{-6})$, where W_{LL} = RED figure in the Load Table, and L = (clear span + .67) in feet.

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	Date	4/20/06	Calc. No.	0100N-CA-C0054	Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters JNW	Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					Sheet No.	26 of 31

STANDARD LOAD TABLE/LONG SPAN STEEL JOISTS, LH-SERIES

Based on a Maximum Allowable Tensile Stress of 30 ksi

Joist Designation	Approx. Wt in Lbs. Per Linear Ft. (Joists only)	Depth in Inches	SAFELOAD* in Lbs. Between		CLEAR SPAN IN FEET															
			28-32		33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
24LH03	11	24	11500		342 235	339 226	336 215	323 204	307 188	293 176	279 162	267 152	255 141	244 132	234 124	224 116	215 108	[illegible] 102	[illegible] 96	[illegible] 90
24LH04	12	24	14100		419 286	398 265	379 246	360 227	343 210	327 194	312 182	298 169	285 158	273 148	262 138	251 130	241 122	231 114	222 107	214 [illegible]
24LH05	13	24	15100		440 308	440 297	440 285	419 264	399 244	380 226	363 210	347 196	331 182	317 171	304 160	292 150	[illegible] 141	[illegible] 132	[illegible]	[illegible]
24LH06	16	24	20300		604 411	579 382	555 356	530 331	504 306	480 284	457 263	437 245	417 228	399 211	381 197	364 184	[illegible] 172	[illegible] 161	[illegible]	[illegible]
24LH07	17	24	22300		665 452	638 421	613 393	588 367	565 343	541 320	518 297	491 276	468 257	448 239	428 223	407 208	389 195	373 182	357 171	343 161
24LH08	18	24	23800		707 480	677 447	649 416	622 386	597 362	572 338	545 314	520 292	497 272	475 254	455 238	435 222	417 208	400 196	384 184	369 173
24LH09	21	24	28000		832 562	808 530	785 501	764 460	731 424	696 393	663 363	632 337	602 313	574 292	548 272	524 254	501 238	480 223	460 209	441 196
24LH10	23	24	29600		882 596	856 559	832 526	809 500	788 474	768 439	737 406	702 378	668 351	637 326	608 304	582 285	556 [illegible]	533 249	511 234	490 220
24LH11	25	24	31200		927 624	900 588	875 555	851 525	829 498	807 472	787 449	768 418	734 388	701 361	671 337	642 316	616 [illegible]	590 [illegible]	567 259	544 243
			33-39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
28LH05	13	28	14000	14000	337 219	323 205	310 192	297 180	286 169	275 159	265 150	255 142	245 133	237 126	228 119	220 113	213 107	[illegible] 102	[illegible] 97	[illegible]
28LH06	16	28	18600	18600	448 289	429 270	412 253	395 238	379 223	364 209	350 197	337 186	324 175	313 165	301 156	291 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28LH07	17	28	21000	21000	505 326	484 305	464 285	445 267	427 251	410 236	394 222	379 209	365 197	352 186	339 176	327 166	316 158	[illegible]	[illegible]	[illegible]
28LH08	18	28	22500	22500	540 [illegible]	517 325	496 305	476 285	456 268	438 [illegible]	420 [illegible]	403 [illegible]	387 209	371 198	357 187	344 177	331 168	[illegible]	[illegible]	[illegible]
28LH09	21	28	27700	27700	667 428	639 400	612 375	586 351	563 329	540 309	519 291	499 274	481 258	463 243	446 229	430 216	415 204	401 193	387 183	374 173
28LH10	23	28	30300	30300	729 466	704 439	674 414	651 389	625 364	600 342	576 322	554 303	533 285	513 269	495 255	477 241	460 228	444 216	429 204	414 193
28LH11	25	28	32500	32500	780 498	762 475	736 448	711 423	682 397	655 373	629 351	605 331	582 312	561 294	540 278	521 263	502 249	485 236	468 223	453 212
28LH12	27	28	35700	35700	857 545	837 520	818 496	800 476	782 454	766 435	737 408	709 383	682 361	656 340	632 321	609 303	587 286	566 270	546 256	527 243
28LH13	30	28	37200	37200	895 569	874 543	854 518	835 495	816 472	799 452	782 433	766 415	751 399	722 373	696 352	669 332	645 314	620 297	598 281	577 266
			38-46	47-48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
32LH06	14	32	16700	16700	[illegible] 211	326 199	315 189	304 179	294 169	284 161	275 153	[illegible] 145	[illegible] 138	[illegible] 131	[illegible] 125	[illegible] 119	[illegible] 114	[illegible] 108	[illegible] 104	[illegible] 99
32LH07	16	32	18800	18800	379 235	366 223	353 211	341 200	329 189	318 179	308 170	298 162	288 154	279 146	271 140	262 133	254 127	247 121	240 116	233 111
32LH08	17	32	20400	20400	411 255	397 242	383 229	369 216	357 205	345 194	333 184	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible] 144	[illegible]	[illegible]	[illegible]	[illegible]
32LH09	21	32	25600	25600	516 319	498 302	480 285	463 270	447 256	432 243	418 230	404 219	391 208	379 198	367 189	[illegible]	[illegible]	[illegible]	[illegible]	315 [illegible]
32LH10	21	32	28300	28300	571 352	550 332	531 315	512 297	495 282	478 267	462 254	445 240	430 228	416 217	402 206	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32LH11	24	32	31000	31000	625 385	602 363	580 343	560 325	541 308	522 292	505 277	488 263	473 251	458 239	443 227	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32LH12	27	32	36400	36400	734 450	712 428	688 406	664 384	641 364	619 345	598 327	578 311	559 295	541 281	524 267	[illegible]	[illegible]	477 232	[illegible]	[illegible]
32LH13	30	32	40600	40600	817 500	801 480	785 461	771 444	742 420	715 397	690 376	666 354	643 336	621 319	600 304	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32LH14	33	32	41800	41800	843 515	826 495	810 476	795 456	780 440	766 417	738 395	713 374	688 355	665 337	643 321	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32LH15	35	32	43200	43200	870 532	853 511	837 492	821 473	805 454	791 438	776 422	763 407	750 393	725 374	701 355	[illegible]	[illegible] 322	[illegible]	[illegible]	[illegible]
			42-46	47-56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
36LH07	16	36	16800	16800	292 177	283 168	274 160	266 153	258 146	251 140	244 134	237 128	230 122	224 117	218 112	212 107	207 103	201 99	196 95	191 91
36LH08	16	36	18500	18500	321 194	311 185	302 176	293 168	284 160	276 153	268 146	260 140	253 134	246 128	239 123	233 118	227 113	221 109	215 104	209 100
36LH09	21	36	23700	23700	411 247	398 235	386 224	374 214	363 204	352 195	342 186	333 179	323 171	314 163	[illegible] 157	[illegible] 150	[illegible]	[illegible]	[illegible]	[illegible]
36LH10	21	36	26100	26100	454 273	440 260	426 248	413 236	401 225	389 215	378 206	367 197	357 188	347 180	[illegible] 173	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36LH11	23	36	28500	28500	496 297	480 283	465 269	451 257	438 246	425 234	412 224	401 214	[illegible] 205	[illegible] 196	[illegible] 188	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36LH12	25	36	34100	34100	593 354	575 338	557 322	540 307	523 292	508 279	493 267	478 256	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36LH13	30	36	40100	40100	697 415	675 395	654 376	634 359	615 342	596 327	579 312	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36LH14	35	36	44200	44200	766 466	755 434	729 412	706 392	683 373	661 356	641 339	621 323	602 309	584 295	567 283	551 270	535 259	520 247	505 237	492 228
36LH15	36	36	46600	46600	800 480	785 464	781 446	762 434	744 413	721 394	698 375	677 358	656 342	637 327	618 312	600 299	583 286	567 274	551 263	536 252

PROPOSED JOIST (SEE SECTION 5.1)

183 lb/ft² CORRESPONDS TO SPAN/360 DEFLECTION [REFERRED TO AS "RED FIGURE" ON PAGE 25 OF THIS CALC.]

Washington Closure Hanford LLC		CALCULATION SHEET					
Originator	I.K. Ghosh IKG	Date	4/20/06	Calc. No.	0100N-CA-C0054	Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters JNW	Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					Sheet No.	27 of 31

Attachment 2: MBCI Deck Load

Trapezoidal Structural Standing Seam Roof Systems

07610/MBC
BuyLine 3903

The snap-together system, Ultra-Dek®, and field seamed system, Double-Lok®, were engineered from concept to installation for strength, durability, and weatherability. The standing seams are a full three inches above the lowest part of the panel, well above the water level as it flows off the roof. The seams have factory-applied mastic to insure a secure, weathertight seam.

BEGINS AND ENDS IN A HIGH

The rake/gable at both ends of each roof system finish with a 3" high standing seam, avoiding the necessity of finishing in the low, flat part of a panel where the greatest possibilities for leaks occur in most other systems.

CONCEALED FASTENING SYSTEM

The standard offering for the Ultra-Dek® and Double-Lok® systems is a floating clip that cannot be installed unless the tab is centered in the clip base. This feature provides for maximum efficiency of the clip and panel.

Special conditions may require the use of the unique Articulating Clip, which is designed to eliminate binding and friction in a misaligned substrate application.

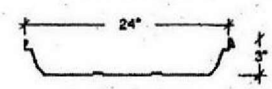
UPLIFT RATINGS

Both systems carry Underwriters Laboratories Fire Resistance and Wind Uplift (UL90) ratings covering a wide range of roof designs. In addition, the Double-Lok® system meets Class 1-60, 1-90, and 1-105 ratings as tested under Factory Mutual Research Corporation Standard 4471. The Double-Lok® system has met all test requirements specified in CEGS 07416/ASTM E1592 Standing Seam Metal Roof System guide specification. Contact MBCI for parameters relating to each panel profile.

APPLICATION

Panels can be installed before or after the exterior walls are in place. All trim is attached after the roof is installed. With a recommended minimum slope of 1/4:12, these roof systems can be used on all types of construction: masonry, metal or wood, for either new construction or retrofit.

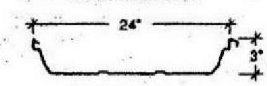
Ultra-Dek®



Snap-Together System
12" and 18" also available

Panel Interlock

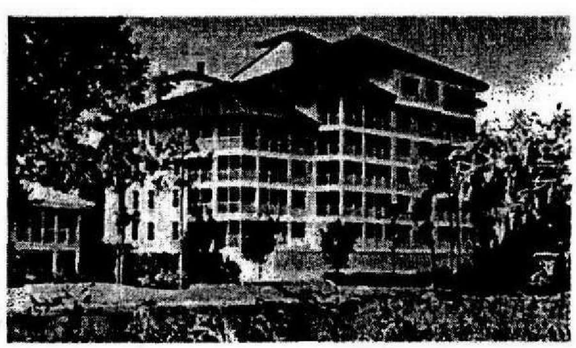
Double-Lok®



Field Seamed System
12" and 18" also available

Panel Interlock

Consult the MBCI DESIGN/INSTALLATION INFORMATION MANUAL for proper application and design details and other product information.



www.mbci.com

Superior Structural Standing Seam Roof Systems 3

Washington Closure Hanford LLC — **CALCULATION SHEET**

Originator	I.K. Ghosh IKG	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters JNW	**Date**	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					**Sheet No.**	28 of 31

Ghosh, Indrajit K

From: Jason Allen [JAllen@ncilp.com]
Sent: Thursday, February 23, 2006 11:42 AM
To: Ghosh, Indrajit K
Subject: RE: Load Table for Trapezoidal Structural Standing Seam Roof Systems
Attachments: DLOK1822WLC.xls; DLOK1822WLCS5.xls; DLOK2422WLC.xls; DLOK2422WLCS5.xls

---

From: Ghosh, Indrajit K [mailto:indrajit.ghosh@wch-rcc.com]
Sent: Thursday, February 23, 2006 12:31 PM
To: Jason Allen
Subject: RE: Load Table for Trapezoidal Structural Standing Seam Roof Systems

Thanks, Jason.

Can you give me the EXCEL file for the following:

5' span for 18" Double-Lok 22 gage with Windclamp
5' span for 18" Double-Lok 22 gage without Windclamp
6' span for 24" Double-Lok 22 gage with Windclamp
6' span for 24" Double-Lok 22 gage without Windclamp

Indra
509-372-9058

From: Jason Allen [mailto:JAllen@ncilp.com]
Sent: Thursday, February 23, 2006 9:27 AM
To: indrajit.ghosh@wch-rcc.com
Subject: FW: Load Table for Trapezoidal Structural Standing Seam Roof Systems

Mr. Ghosh,

Here is the information you requested. This chart does not have 1/3 increase for wind.

Thanks

Jason Allen, EIT
Sales Engineer/Test Lab Manager
MBCI
281-445-8555 ext 28612

From: Brian Jaks
Sent: Thursday, February 23, 2006 10:17 AM
To: Jason Allen
Subject: FW: Load Table for Trapezoidal Structural Standing Seam Roof Systems

Washington Closure Hanford LLC — **CALCULATION SHEET**

Originator	I.K. Ghosh *IKG*	Date	4/20/06	Calc. No.	0100N-CA-C0054	Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters *JNW*	Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure					Sheet No.	29 of 31

MBCI®
Metal Roof and Wall Systems

FOR INTERNAL USE ONLY

18" Double-Lok® 22 Ga.
Negative Design Loads (psf)

Span	1592 Load	Design Load
0.50	264.33	148.50
1.00	253.06	142.17
1.50	241.80	135.84
2.00	230.53	129.51
2.50	219.27	123.18
3.00	208.00	116.85
3.50	186.34	104.68
4.00	164.67	92.51
4.50	143.01	80.34
5.00	121.34	68.17
5.50	99.68	56.00
6.00	78.01	43.83

Notes:
1) Above loads for use with HW-214, HW-216, HW-3140, HW-3160, HW-2122, HW-2124, HW-2126 and HW-2126.
2) The above loads were derived from uplift tests done in accordance with ASTM E-1592.
3) Test results are highlighted.
4) All values are interpolated and/or extrapolated from tests performed at spans of 2'-0", 3'-0" and 5'-0".
5) Design Load contains a 1.78 factor of safety.
6) These values do not consider fastener pullout or pullover, clip attachment must be designed separately.
7) The use of any field seaming equipment or accessories including but not limited to clips, fasteners, and support plates (eave, backup, rake, etc.) other than tha provided by the manufacturer may damage panels, void all warranties and will void all engineering data.
8) This material is subject to change without notice. Please contact MBCI for most current data.

Effective Date: August 30, 2005

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh	Date	4/20/06	Calc. No.	0100N-CA-C0054		Rev.	A
Project	River Corridor Closure Contract	Job No.	14655	Checked	J.N. Winters		Date	4-20-06
Subject	Conceptual Design of 105N/109N Interim Safe Storage Enclosure						Sheet No.	30 of 31

MBCI®
Metal Roof and Wall Systems

FOR INTERNAL USE ONLY

24" Double-Lok® 22 Ga.

Negative Design Loads (psf)

Span	1592 Load	Design Load
0.50	248.45	140.37
1.00	223.60	126.33
1.50	198.76	112.29
2.00	173.92	98.26
2.50	149.07	84.22
3.00	139.71	78.93
3.50	130.35	73.64
4.00	120.99	68.36
4.50	111.63	63.07
5.00	102.27	57.78
5.50	92.91	52.49
6.00	83.55	47.20

Notes:

1) Above loads for use with HW-214, HW-216, HW-3140, HW-3160, HW-2122, HW-2124, HW-2126 and HW-2128.
2) The above loads were derived from uplift tests done in accordance with ASTM E-1592.
3) Test results are highlighted.
4) All values are interpolated and/or extrapolated from tests performed at spans of 1'-0", 2'-6" and 5'-0".
5) Design Load contains a 1.77 factor of safety.
6) These values do not consider fastener pullout or pullover, clip attachment must be designed separately.
7) The use of any field seaming equipment or accessories including but not limited to clips, fasteners, and support plates (eave, backup, rake, etc.) other than the provided by the manufacturer may damage panels, void all warranties and will void all engineering data.
8) This material is subject to change without notice. Please contact MBCI for most current data.

Effective Date: August 30, 2005

Washington Closure Hanford LLC **CALCULATION SHEET**

Originator	I.K. Ghosh	**Date**	4/20/06	**Calc. No.**	0100N-CA-C0054	**Rev.**	A
Project	River Corridor Closure Contract	**Job No.**	14655	**Checked**	J.N. Winters	**Date**	4-20-06
Subject	**Conceptual Design of 105N/109N Interim Safe Storage Enclosure**					**Sheet No.**	31 of 31

MBCI®

Metal Roof and Wall Systems

Double-Lok® PANEL
24" Coverage

ALLOWABLE UNIFORM LOADS IN POUNDS PER SQUARE FOOT

24 Gauge (Fy = 50 KSI)								
SPAN TYPE	**LOAD TYPE**	**SPAN IN FEET**						
		2.5	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**
SINGLE	LIVE	204.0	170.0	145.7	127.5	113.3	102.0	86.2
2-SPAN	LIVE	204.0	170.0	145.7	123.4	97.5	79.0	65.3
3-SPAN	LIVE	204.0	170.0	145.7	127.5	113.3	98.7	81.6
4-SPAN	LIVE	204.0	170.0	145.7	127.5	113.3	92.2	76.2

22 Gauge (Fy = 50 KSI)								
SPAN TYPE	**LOAD TYPE**	**SPAN IN FEET**						
		2.5	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**
SINGLE	LIVE	296.9	247.5	212.1	185.6	165.0	136.3	112.7
2-SPAN	LIVE	296.9	247.5	212.1	173.9	137.4	111.3	92.0
3-SPAN	LIVE	296.9	247.5	212.1	185.6	165.0	139.1	115.0
4-SPAN	LIVE	296.9	247.5	212.1	185.6	160.4	129.9	107.4

NOTES:

1) Allowable loads are based on uniform span lengths and Fy = 50 ksi.
2) LIVE LOAD is limited by bending, shear, combined shear & bending
3) Above loads consider a maximum deflection ratio of L/180.
4) The weight of the panel has not been deducted from the allowable loads.
5) **THE ABOVE LOADS ARE NOT FOR USE WHEN DESIGNING PANELS TO RESIST WIND UPLIFT.**
6) Please contact manufacturer or manufacturer's website for most current allowable wind uplift loads.
7) The use of any field seaming equipment or accessories including but not limited to clips, fasteners, and support plates (eave, backup, rake, etc.) other than tha provided by the manufacturer may damage panels, void all warranties and will void all engineering data
8) This material is subject to change without notice. Please contact MBCI for most current data

The Engineering data contained herein is for the expressed use of customers and design professionals. Along with this data, it is recommended that the design professional have a copy of the most current version of the *North American Specification for the Design of Cold-Formed Steel Structural Members* published by the American Iron and Steel Institute to facilitate design This Specification contains the design criteria for cold-formed steel components. Along with the Specification, the designer should reference the most current building code applicable to the project jobsite in order to determine environmental loads If further information or guidance regarding cold-formed design practices is desired, please contact the manufacturer.

Subject to change without notice. Effective April 7, 2005.

DISTRIBUTION

U.S. Department of Energy
Richland Operations Office

K. D. Bazzell	A3-04
D. C. Smith (9)	A3-04

Washington Closure Hanford

J. P. Delaney	X0-18
R. G. Egge	X5-50
K. A. Hadley	X0-18
E. G. Ison	X0-18
D. N. LaRue	H0-20
D. E. Reese	X0-18

Document and Information Services (2)	H0-30
DOE-RL Public Reading Room	H2-53
Hanford Technical Library	P8-55
Administrative Record (6)	H6-08